BRITISH DEFENCE EQUIPMENT CATALOGUE

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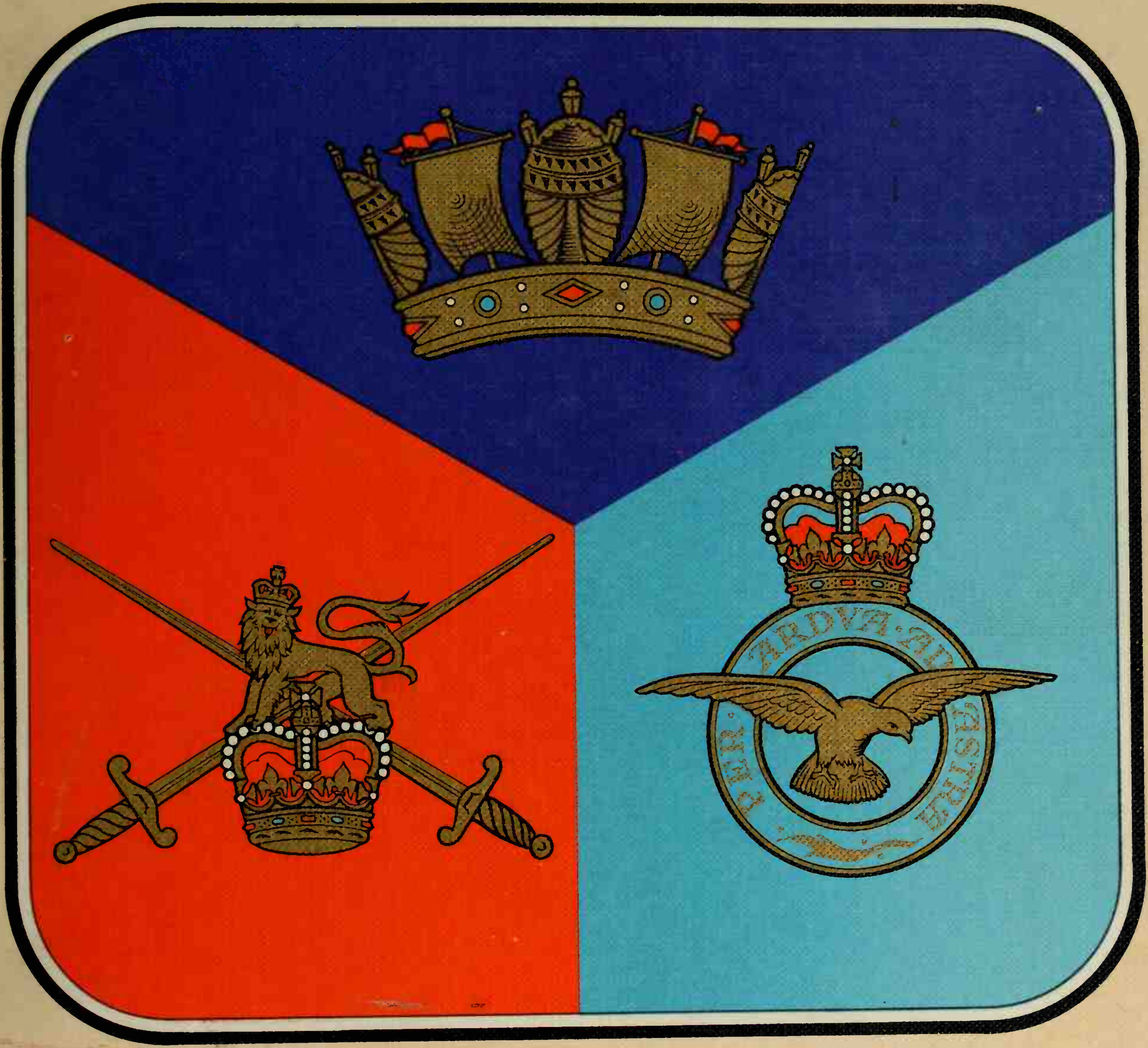
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BRITISH
DEFENCE EQUIPMENT
CATALOGUE

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Introduction

British industry manufactures a very wide range of defence equipment proven in battle round the world. In recent years many items of such equipment have been sold to other countries both by British industry and by the British Ministry of Defence.

Although all manufacturers issue technical literature describing their products and many offer very detailed brochures, it is felt that there is a need for a joint catalogue of defence equipment such as this publication. This sets out to provide a quick and easy reference to the widest possible range of products and services, information about each being presented in a uniform layout.

We do not claim that all items of defence equipment manufactured in Britain are included or described. Some are too complex to include in this type of presentation, others of which you may have heard are not yet in service. If you want further information on any of the items or if you cannot find the type of equipment for which you are looking, help will be forthcoming from the British Embassy—or High Commission if appropriate—in your country. Alternatively, your representatives in London can seek further information from the British Ministry of Defence or Ministry of Technology.

It should be noted moreover that contributors to this Catalogue have been able to select only one or, at best, a few of their products for inclusion in the product data sections; other products made by the contributor are indicated against their name in the alphabetic list.

This edition contains updated and new information, and therefore supersedes the second edition dated December 1969, all copies of which should be destroyed. The next (fourth) edition will be published in the Autumn of 1971, it having been decided that it is now necessary to publish the Catalogue only once a year in future.

This Catalogue has been sponsored by the British Ministries of Defence and Technology and has been prepared with the fullest assistance and co-operation of the many firms participating.

Application for further copies of this edition should be addressed to the publishers: Combined Service Publications Limited, 67/68 Jermyn Street, London SW1, England.

How to use this Catalogue

The products shown in this Catalogue are grouped into sections relating to broadly comparable defence purposes. As far as possible, the sections themselves are grouped to bring together equipment for naval, army and air use. On page 3 will be found a list of these section headings with page numbers.

On pages 9–34 there is a comprehensive index of all the products included, arranged alphabetically irrespective of section, giving the page numbers on which descriptive details are published.

On pages 35–56 there is a list of all the firms concerned, arranged alphabetically. If details of a product or products made by a particular firm are required, these may be found from the page numbers listed in the firm's alphabetic list entry. This list also contains more details of the firms themselves, such as locations of separate divisions or branches, as well as products not described in this publication.

While every care has been taken to ensure that the data published in this Catalogue are correct, the publishers accept no responsibility for any of the information.

The right is reserved to change specifications without prior notice at any time.

The trade marks and trade names used in this Catalogue must not be reproduced without permission of the firms concerned. All text and illustrations in this Catalogue are copyright and must not be reproduced without permission of the publishers.

To our many friends we apologise that this Catalogue is printed only in English. Where further explanation is required, assistance can always be obtained from the Embassies of Great Britain, including our Service Attaches.

Queen's Award to Industry

This symbol, which will be found on many pages in this Catalogue, denotes that the firm concerned has received the Queen's Award to Industry for outstanding achievements in the year or years indicated under the symbol.

Comment consulter ce Catalogue

Les produits répertoriés au Catalogue sont groupés par rubriques se rapportant à des fins militaires d'ordre similaire. Ces rubriques sont groupées autant que possible de façon à réunir les équipements des services de l'armée, de l'air et de la marine. On trouvera à la page 3 une liste de ces rubriques, avec leurs numéros de pages.

Il est publié aux pages 9–34 un répertoire de tous les produits inclus au Catalogue, par ordre alphabétique, indépendamment de la rubrique et indiquant la page où se trouvent les descriptions s'y rapportant.

Une liste paraît aux pages 35–56 où figurent alphabétiquement toutes les sociétés mentionnées. Pour trouver des informations sur un ou des produits fabriqués par une société donnée, se référer aux pages indiquées à la liste alphabétique des sociétés; cette liste procure d'autres renseignements sur les sociétés, comme par example les adresses des services et filiales qui ont leur propre siège, ainsi que d'autres produits non décrits au présent Catalogue.

Tandis que les éditeurs ont pris soin d'assurer que les informations publiées au Catalogue sont exactes, ils ne peuvent accepter aucune responsabilité en ce qui concerne toutes ou partie de ces informations.

Les sociétés se réservent le droit de modifier les spécifications à tout moment donné, sans avis préalable.

Les marques et les noms commerciaux qui figurent au Catalogue ne seront pas reproduits sans la permission des sociétés concernées. Tous les textes et illustrations du Catalogue ne peuvent être reproduits sans la permission des editeurs qui s'en réservent le droit de publication.

Nous prions nos bons amis nombreux de bien vouloir nous excuser de l'absence d'une version française de cet Catalogue. Pour des renseignements supplémentaires on peut toujours s'adresser aux Ambassades de la Grande Bretagne ou à ses Attachés Militaires.

Le Prix Royal decerne a l'industrie

Ce symbole qu'on recontrera souvent aux pages du Catalogue indique que la société concernée s'est vu décerner le Prix Royal à l'Industrie pour son important apport au cours de l'année ou des années portées en dessous du symbole.

Modo de usar este Catálogo

Los productos ilustrados en este Catálogo están agrupados por secciones que guardan relación con finalidades de defensa comparables en términos generales. Dentro de lo posible las secciones mismas están a su vez ordenadas en grupos con el fin de reunir los equipos y material destinados a las fuerzas de tierra, mar y aire. En la página 3 se hallará una lista de los encabezamientos de estas secciones con indicación de los números de las páginas.

En las páginas 9–34 hay un índice completo de todos los productos incluidos, dispuestos alfabéticamente cualquiera que sea la sección a que pertenece y con indicación de los números de las páginas en las que se publican los detalles descriptivos.

En las páginas 35–56 hay una lista de todas la firmas interesadas, por orden alfabético. Si se desea conocer detalles de un producto o productos fabricados por una firma determinada, pueden hallarse dirigiéndose a los números de páginas indicados en la lista alfabética de las empresas. Esta lista contiene también más datos de las firmas propiamente dichas, tales como la direcciones de las distintas divisiones y sucursales, así como productos que no se describen en este Catálogo.

Si bien se han adoptado todas las precauciones necesarias para asegurar que sean correctos todos los datos publicados en este Catálogo, los editores no aceptan responsabilidad alguna por la información facilitada en el mismo.

Queda reservado el derecho a modificar especificaciones sin previo aviso en cualquier momento dado.

No está permitida la reproducción de ninguno de los nombres y marcas registrados utilizados en este Catálogo sin el previo consentimiento de las firmas interesadas. Todo el texto y las ilustraciones de este Catálogo están sujetos a las leyes del derecho de autor y no está permitida su reproducción sin el previo consentimiento de los editores.

Rogamos a nuestros numerosos amigos de excusarnos de que este Catálogo sea impreso unicamente en inglés. Más amplios informes pueden ser obtenidos de las Embajadas de Gran Bretaña y de sus agregados militares.

El Galardon de la Reina a la Industria

Este símbolo, que se verá en muchas páginas de este Catálogo, indica que la firma ha sido galardonada con el Premio de la Reina a la Industria por haber logrado éxitos sobresalientes en al año o los años mencionados bajo el símbolo.

Zum Gebrauch des Katalogs

Die in diesem Katalog beschriebenen Erzeugnisse sind in Abschnitte gegliedert, die annähernd vergleichbaren Verteidigungszwecken entsprechen. Soweit wie möglich, sind die Abschnitte selbst so angeordnet, dass Ausrüstungsartikel für die Marine, Armee und Luftwaffe zusammengefasst sind. Auf Seite 3 befindet sich ein Verzeichnis dieser Abschnitts-Überschriften mit Angabe der Seitenzahl.

Die Seiten 9–34 enthalten—ungeachtet der Einteilung in Abschnitte—in alphabetischer Reihenfolge ein umfassendes Register aller aufgeführten Produkte mit Angabe der Seite, auf der die detaillierte Beschreibung zu finden ist.

Die Seiten 35–56 enthalten ein komplettes Firmenverzeichnis, alphabetisch geordnet. Werden Einzelheiten über ein von einer bestimmten Firma hergestelltes Produkt gewünscht, so sind diese an Hand der Seitenzahlen zu finden, die im alphabetisch angeordneten Firmenverzeichnis angegeben sind. Dieses Verzeichnis enthält auch Mitteilungen über die einzelnen Firmen, wie z.B. Anschriften von Abteilungen oder Filialen, sowie über Produkte, die in diesem Katalog nicht beschrieben sind.

Obwohl mit grösster Sorgfalt darauf geachtet wurde, dass die Angaben in diesem Katalog richtig sind, lehnt der Verlag jede Haftung ab.

Die Herstellerfirmen behalten sich das Recht vor, jederzeit ohne vorherige Benachrichtigung Spezifikationen zu ändern.

Die in dem Katalog vorkommenden Warenzeichen und Firmennamen dürfen nicht ohne schriftliche Einwilligung der Firmen nachgedruckt werden. Alle Texte und Illustrationen des Katalogs sind urheberrechtlich geschützt. Nachdruck ohne Einwilligung des Verlags ist untersagt.

Wir bitten unsere Überseekunden höflichst um Nachsicht, dass dieser Katalog nur in englisch gedruckt ist. Falls zusätzliche Erläuterungen erwünscht sein sollten, können sie jederzeit von den Botschaften Grossbritanniens, einschliesslich der Militärattachés, eingeholt werden.

Königlicher Industriepreis

Dieses Zeichen, das auf zahlreichen Seiten des Katalogs erscheint, zeigt an, dass die Firma in einem oder mehreren Jahren mit dem Queen's Award to Industry für hervorragende Leistungen ausgezeichnet wurde.

Manuseamento do Catalogo

Os produtos mostrados neste Catálogo estão agrupados em secções relacionadas em termos gerais a fins defensivos comparáveis. Tanto quanto possível, as secções, de per si, estão agrupadas catalogando equipamento usado por forças navais, aéreas e do exército. Na página 3 encontra-se uma lista com os títulos destas secções e os números das páginas em que se encontram.

Nas páginas 9–34 encontra-se um índice compreendente todos os produtos incluidos, dispostos alfabèticamente, irrespectivamente da secção a que pertencem, com os números das páginas onde se encontram os pormenores descritivos.

Nas páginas 35–56 encontra-se uma lista de todas as firmas interessadas em ordem alfabética. Se forem desejados pormenores de um produto ou produtos feitos por determinada firma, estes podem obter-se pelos números da página que se encontram na lista alfabética das firmas. Esta lista dá também mais pormenores sobre as firmas como, por exemplo, localização de divisões separadas ou sucursais, bem como de produtos que não se encontram nesta publicação.

Não obstante ter sido tomado o maior cuidado para assegurar a exactidão dos dados publicados neste Catálogo, os editores não aceitam qualquer responsabilidade pelas informações fornecidas.

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Pedimos desculpas aos nossos Exm^{os} amigos que êste Catálogo seja redigido exclusivamemte em Inglês. Se se precisem mais explicações as Embaixadas Britanicas, inclusivo os adidos militares, ficarão sempre às suas ordens para lhas fornecer.

Real Ordem de Mérito Industrial

Este símbolo, que se encontra em muitas páginas deste Catálogo, significa que a firma respectiva foi galardoada com a Real Ordem de Mérito Industrial em reconhecimento de realizações de relêvo no ano ou anos indicados à parte inferior do símbolo.

This is not a comprehensive index of defence equipment: only products dealt with in this Catalogue are listed.

Opposite each product will be found the number of the page or pages on which the product is described.

Items printed in bold type indicate section headings.

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AB Electronic Components Ltd Sutherland House 5–6 Argyll Street London W1V 1AD England	01-437 7581		49606	Electrical connectors	310–311	
AEC Ltd *Military Sales Division* Berkeley Square House Berkeley Square London W1 England	01-499 6050	Leymotors London W1 Telex	22498	*Militant III* 10-ton cargo truck	284–285	
Aeronautical & General Instruments Ltd 40 Purley Way Croydon CR9 3BH England	01-684 3211	Instradio Croydon	262960	Electro-magnetic ship's log	142	Gas detection equipment, servo test equipment-correlator
				Reconnaissance cameras	406–407	
Air-Log Ltd North Lane Aldershot Hampshire England	Aldershot 24411	Airlogco Aldershot		Portable power generating sets	578–579	Aircraft ground support and servicing equipment, armament ground support and check-out systems
Airmed Ltd *Aviation Division* Edinburgh Way Harlow Essex England	Harlow 24331	Airmed Harlow	81338	Telecommunication headsets with boom-mounted microphones	534	Gas flowmeters, regulators, peak flowmeters, oxygen breathing equipment
Medical Division Edinburgh Way Harlow Essex England	Harlow 24331	Airmed Harlow	81338	General anaesthesia and oxygen therapy apparatus, flowmeters and regulators	683	
Airscrew-Weyroc Ltd *Fan Division* Weybridge Surrey England	Weybridge 45599			Cooling fans for the *Scorpion* and other fighting vehicles	328	
Airtech Ltd Haddenham Aylesbury Buckinghamshire England	Haddenham 422	Airtech Haddenham	83223	Cloud base recorder system for airfields or meteorological stations	442	Design and installation of mobile radar and telecommunications systems, VHF and UHF duplexers, VHF and UHF filters (stop band, bandpass, tunable), power-line filters (up to 200 arms), signal filters (telephone line, etc)
				UHF multicoupler system	528	
				Airportable cabins and trailer-type running gear	689	
Airwork Services Ltd Bournemouth (Hurn) Airport Christchurch Hampshire BH23 6EB England	Northbourne 2271	Airwork Xchurch	41282	Technical support and advice for military and civil authorities	702–703	Design and development of special aircraft installations and modifications, testing of aircraft seats and structures, technical publications
London Office Portland House Stag Place London SW1 England	01-834 9477					
Albion Motors Ltd *Military Sales Division* Berkeley Square House Berkeley Square London W1 England	01-499 6050	Leymotors London W1 Telex	22498	*Albion* 4½/5 ton general service cargo truck	286–287	
Allis-Chalmers Great Britain Ltd Essendine Stamford Lincolnshire England	Stamford 2471	Gyrating Stamford	32255	Articulated wheel loader	270–271	
Alvis Ltd Holyhead Road Coventry CV5 8JH England	Coventry 25501	Alvis Coventry Telex	31459	*Scorpion* light tank	184–185	
				Scorpion variants	186–187	
				Saladin amoured car	188–189	
				Saracen armoured troop carrier	190–191	
				Stalwart load carrier	192–193	
Ardrox Ltd Commerce Road Brentford Middlesex England	01-560 5444	Ardrox Brentford Telex	23609	Chemicals and equipment for surface treatment, cleaning and flaw detection	730–731	
Auto Diesels Braby Ltd Cowley Mill Road Uxbridge Middlesex England	Uxbridge 38262	Courteous Uxbridge	263835	Gas turbines for generating sets	590	

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Avimo Ltd Herbert Street Taunton Somerset England	Taunton 81071	Avimo Taunton	46126	Small arms day/night sight Small portable radar torch Vehicle and airborne optics, military optics Simulators for anti-tank guided weapons	252 252 252 557	
Avo Ltd Avocet House Dover Kent England	Dover 2626	Avocet Dover	96283	Test instruments	668	
Avon Footwear Ltd Bridgend Glamorgan South Wales	Bridgend 3211	Rubber Bridgend	44142	Rubber compounds for service footwear	699	
Avon Medicals-Avon Rubber Co Ltd *Industrial Products Division* 1649 Pershore Road Stirchley Birmingham 30 England	021-458 6324	Avon Medicals Birmingham 30		Disposable transfusion and dialysis equipment and accessories	683	
Avon Rubber Co Ltd *Industrial Products Division* Bradford-on-Avon Wiltshire England	Bradford-on-Avon 2191	Industrial Bradford-on-Avon	44856	Rubber components and products for naval equipment Rubber components for fighting vehicles Hovercraft skirts and skirt systems Rubber components for aircraft	175 330 376 434	
Tyre Division Melksham Wiltshire England	Melksham 3101	Rubber Melksham	44142	Tyres Pneumatic and solid tyres	330 645	
Barr & Stroud Ltd Caxton Street Anniesland Glasgow W3 Scotland	041-954 9601	Telemeter Glasgow	778114	Periscopes, distress buoys and compass test tables Sights, laser range finders and special optics	108 232–233	Night viewing equipment, radar homers, code generators, ultra high-speed cameras, fibre optics, optical and electronic filters
London Office Kinnaird House 1 Pall Mall East London SW1 England	01-930 1541	Retemelat London SW1	261877			
Beaufort (Air-Sea) Equipment Ltd Beaufort Road Birkenhead Cheshire England	051-652 2667		62478	Survival equipment: lifejackets, clothing, liferafts and boats	594–595	Proofed and tested fabrics, air-portable hangars, radomes, helicopter landing pads, special plastic and rubber mouldings
Belling & Lee Ltd *Radio Frequency Interference Division* Great Cambridge Road Enfield Middlesex	01-363 5393	Radiobel Enfield	263265	Shielded enclosures for combating radio frequency interference	529	Electronic components, television distribution equipment
Black & Edgington Ltd Ruxley Corner Works Sidcup Kent England	01-302 0211	Benedge Sidcup	897371	Tents	690	Tarpaulins, water dams
T T Boughton & Sons Ltd *Engineering Division* Bell Lane Amersham Buckinghamshire England	Little Chalfont 2666	Boughtons Amersham	83132	Hydraulic and mechanical winches	260–261	
Brandhurst Co Ltd Wellington Road High Wycombe Buckinghamshire England	High Wycombe 25106			Self-luminous products: compounds, nuclear lamps, signs and markers	747	
Head Office Vintry House Queen Street Place London EC4 England	01-236 1411	Brandcolim London EC4	262632			
Bridport-Gundry Ltd *Industrial Division* Bridport Dorset England	Bridport 2244	Netting Bridport	41132	Nylon nets and netting for camouflage, cargo movement and restraint	742	Fishing nets, sports nets, horticultural nets

Name and address	Telephone	Cables	Telex	Products described	Page	Other products made
Bristol Pneumatic Tools Ltd Causeway Works Fishponds Bristol BS16 3JS England	Bristol 657511	Percussion Bristol	44641	Portable and stationary air compressors	264	
British Aircraft Corporation Ltd *Guided Weapons Division* Six Hills Way Stevenage Hertfordshire England	Stevenage 2422	Britair Stevenage	82125	*Vigilant* guided missile *Rapier* guided missile *Thunderbird* guided missile *Swingfire* guided missile	450–451 452–453 454–455 456–457	
Precision Products Group Six Hills Way Stevenage Herts England	Stevenage 2422	Britair Stevenage	82125	Gun sight with automatic digital elevation read-out	240	
Preston Division Warton Aerodrome Preston PR4 1AX England	St Annes 21255	Britair Warton	67627	*Canberra* aircraft *Lightning* aircraft *Strikemaster* aircraft	340–341 342–343 344–345	*Jaguar* tactical support and operational training aircraft
London Office 100 Pall Mall London SW1 England	01-930 1020					
The British Aluminium Co Ltd Norfolk House St James's Square London SW1 England	01-839 8888	Britalumin London SW1	22756	Aluminium alloy armour plate Landing mats and pads for aircraft and helicopters	330 440	
The British Hoist and Crane Co Ltd Compton Newbury Berkshire England	Compton 301	Brithoist Compton Newbury	84358	*Iron Fairy* hydraulic cranes	645	
British Hovercraft Corporation East Cowes Isle of Wight England	Cowes 4121	Brithover Cowes	86190	*Wellington* hovercraft *Winchester* hovercraft	370–371 372–373	Design, development and production of commercial and military hovercraft, hoverpallets, air-cushion heavy-load transporters
British Manufacture & Research Co Ltd Springfield Road Grantham Lincolnshire England	Grantham 2101	Marco Telex Grantham	37635	Gun mounting for vessels of all types Gyro-stabilised twin 30-mm anti-aircraft gun Ammunition for *Aden* aircraft cannons	138–139 208–209 387	
Britten-Norman Sales Ltd Bembridge Airport Bembridge Isle of Wight England	Bembridge 2511	Britnor Bembridge	86277	*Islander* aircraft	346–347	
J Brockhouse & Co Ltd *Vehicles Division* Victoria Works Hill Top West Bromwich Staffordshire England	021-556 1241	Brockhouse West Bromwich	33631	Cargo and special-purpose trailers	338	Ground heating trolleys, pneumatic servicing trolleys, aircraft starting trolleys, armament handling equipment, aircraft servicing trestles, field kitchen trailers
London Office 25 Hanover Square London W1R 0DQ England	01-629 8783		25248			
Brooke Marine Ltd Lowestoft Suffolk England	Lowestoft 5221	Brookcraft Lowestoft	97145	Corvette Strike craft Twin-screw patrol craft Twin-screw patrol boats Survey craft	58–59 60–61 62–65 66–67 84–85	
Head Office Dowsett Holdings Ltd The Offices Greatford Stamford Lincolnshire England	Greatford 301	Dowsett Stamford	32108			
Brown Best & Co Ltd 102 Old Kent Road London SE1 England	01-703 8111	Abri London SE1		Rucksacks, haversacks, manpack frames	699	Groundsheets, instrument cases

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David Brown Gear Industries Ltd *Gear Division* Park Gear Works Huddersfield Yorkshire England	Huddersfield 22180	Gearing Huddersfield	51562	Marine main propulsion gearing	154–155	Speed reduction gears and gear units for auxiliary drives
S G Brown Ltd Greycaine Road Watford Hertfordshire WD2 4XU England	Watford 27241	Sidbrownix Watford	23408	Gyro reference system for ship's navigation and weapons control Land navigation systems for military vehicles	124–125 230–231	
Communication Division King George's Avenue Watford Hertfordshire England	Watford 23301	Radiolink Watford	23412	Handsets, headsets and microphones Intercom equipment for military and civil aircraft	510–511 512–513	
Brown & Son (Alembic Works) Ltd 10–11 Lime Street London EC3 England	01-626 1801	Rawsonship London EC3		Hospital and laboratory apparatus	683	
David Budworth Ltd Kings Quay Street Harwich Essex England	Harwich 3116	Budworth Harwich		Small gas turbines, turbo-compressors, turbo-generator sets, de-icers, turbo-fans	591	Ground heater units, electronic tachometer indicators, engine and process control units
Burndept Electronics (ER) Ltd St Fidelis Road Erith Kent England	Erith 39121	Electronics Erith	21246	Radio search and rescue beacons	596–597	Radio telephones
CAV Ltd Warple Way London W3 England	01-743 3111	Vanteria London W3	27881	Fuel and electrical units for fighting vehicles	312–313	Low-voltage dc motors for traction and hydraulics, low-voltage power system
Cammell Laird (Anglesey) Ltd Beaumaris Anglesey North Wales	Beaumaris 431	Searoads Beaumaris	61295	Compression chambers Portable bridges Truck-laid and heavy-duty portable roadways	100–101 256–257 258–259	Airport passenger loading bridges and stairways; refuse collection vehicles; light stainless steel and non-ferrous castings; design, fabrication, machining and assembly of light to medium engineering structures and equipment in aluminium alloy, steel and glassfibre-reinforced plastics
Cammell Laird (Shiprepairers) Ltd Birkenhead L41 5HG England	051-647 7060	Drydocks Birkenhead	627011	Ship refitting for warships	704–705	
Caterpillar Tractor Co Ltd 55 St James's Street London SW1 England	01-493 1882	Caterpillar London SW1	262931	Tractors and scrapers	272–273	Wheel loaders, motor graders, pipelayers, wheel tractors, industrial engines
Head Office PO Box 162 Glasgow Scotland	Uddingston 2921	Caterpillar Glasgow	77721			
Chelsea Quilt Co Ltd Riverside Works Barnstaple Devon England	Barnstaple 72345		46106	Sleeping bag, rucksack, personal load-carrying equipment	692–693	
London Office PO Box 625 London SW11 England	Barnstaple 72345		267700			
Chiltern Hunt Ltd Belswain Lane Hemel Hempstead Hertfordshire England	Hemel Hempstead 51511 and King's Langley 3264	Chiltern Hemel Hempstead		Ammunition containers	648–649	
Clos o Mat (Great Britain) Ltd 2 Brooklands Road Sale Cheshire M33 2SS England	061-973 1234			Automatic lavatory for wounded and handicapped	683	

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Consolidated Pneumatic Tool Co Ltd 97–101 Uxbridge Road London W5 England	01-567 3411		21311	Portable electric tools	265	
Coopers Mechanical Joints Ltd Llanfoist Works Abergavenny Monmouthshire Wales	Abergavenny 2041			Self-cleaning air filters for protecting engines in severe dust conditions	329	
Cossor Electronics Ltd *Avionics and Surface Electronics Division* The Pinnacles Harlow Essex England	Harlow 26862	Cossor Harlow	81228	Secondary surveillance radar for air traffic control and defence	468–469	Alphanumeric and graphic video displays, computer peripheral equipment, SSR defruiter systems, SSR decoder, oscilloscopes, UHF and VHF radio communications equipment (land and marine)
Coventry Climax Engines Ltd *Military Sales Division* Berkeley Square House Berkeley Square London W1 England	01-499 6050	Leymotors London W1 Telex	22498	Military gasolene and and diesel engines Small military multi-fuel and diesel engines Portable, trailer- and vehicle-mounted fire pumps Mechanical fork lift trucks Electric fork lift trucks	560–561 562–563 616–617 628–629 630–631	Electric tow tractors, electric platform trucks, fork lift truck attachments
Crane Fruehauf Trailers Ltd South Green Works Dereham Norfolk England	Dereham 2311	Cranefrue Dereham	97494	Semi-trailers	332–333	Cargo containers, couplings
Head Office Mills House 649–655 London Road Isleworth Middlesex England	01-568 0641	Cranefrue Isleworth	262051			
Joseph Crosfield & Sons Ltd *Industrial Chemicals Division* PO Box 26 Warrington Lancashire England	Warrington 31211	Crosfields Warrington	627067	Desiccants	653	Sodium and potassium silicates, silica sols, industrial detergents, sodium toluene and xylene sulphonates, synthetic fluid catalysts, nickel catalysts, fine silicas and silicates, micronised silica gels, ion exchange and base exchange materials, sodium ferrite, textile oils and auxiliaries and concrete auxiliaries
London Office Avon House 360–366 Oxford Street London W1	01-493 6372	Savonnier London W1	262269			
John Curran Ltd PO Box 72 Curran Road Cardiff CF1 1TE Wales	Cardiff 20641	Narruc Cardiff		Mobile engine run-up stands	436–437	Turning gear and aerial mounts for ground radar and radio telescopes; g force measuring equipment; specialist aeronautical and mechanical design, development and manufacture
The Daimler Co Ltd Daimler Road Radford Coventry England	Coventry 27626	Daimler Coventry	31459	*Fox* armoured car *Ferret* scout cars	194–195 196–199	
Dale Electric of Great Britain Ltd Electricity Buildings Filey Yorkshire England	Filey 2011	Dalectric Filey	52163	Portable and trans-portable power plants Mobile power plants	580–581 582–583	Prime power and standby generating sets, vehicle-mounted welding sets, cable drum-handling device
S Davall & Sons Ltd Wadsworth Road Greenford Middlesex England	01-998 1011	Davall Greenford		Airborne tape cassette record/replay equipment	530	Crash recorders, engine starters, de-icing timers, delayed device arming, printed circuits, relays, sonic strain gauges for civil engineering
The Decca Navigator Co Ltd Decca House 9 Albert Embankment London SE1 England	01-735 8111	Decnav London SE1	28588	Navigation systems	514–515	

Name and address	Telephone	Cables	Telex	Products described	Page	Other products made
Decca Radar Ltd *Industrial Sales Division* Decca House 9 Albert Embankment London SE1 England	01-735 8111	Decradar London SE1	28588	Automated infusion unit	683	
Marine Division Decca House 9 Albert Embankment London SE1 England	01-735 8111	Decradar London SE1	28588	Marine navigational radar	112–113	Integrated ship instrumentation system
Defence Instruments (Optical) Ltd 145 Queen Street Glasgow C1 Scotland	041-221 6666	Binocam Glasgow		Sights, telescopes and periscopes	239	Air survey instruments, compasses, altimeters, clinometers
Sudbury House Tylney Road Bromley Kent England	01-460 4665	Optic Sales Edenbridge		Optical systems for photogrammetry and surveying	266	
Dowsett Engineering Construction Ltd Bilton Hall Harrogate Yorkshire England	Harrogate 2664	Dowsett Harrogate		Construction services for defence, industrial and civil projects	706–707	
Driclad Ltd Staplehurst Road Sittingbourne Kent England	Sittingbourne 4422	Expac Sittingbourne	96180	Protective operational storage system for valuable equipment	650–651	Grain silos; metal, wood and plastics containers
The Dunlop Co Ltd *Aviation Division—* *Military Equipment Sales* Holbrook Lane Coventry CV6 4AA England	Coventry 88733	Sound Coventry	31677	Disc brakes for marine main propulsion transmissions	162	Hydro-pneumatic vehicle suspension systems, hydraulic and pneumatic systems, light weapon stabilisation system, tracked vehicle brakes
New Products Division Holbrook Lane Coventry CV6 4AA England	Coventry 88733	Sound Coventry	31677	Breathing apparatus	102–103	Height-pressure air valves, panels for breathing-set charging, air-suspension systems for vehicles, anti-skid systems for vehicles
London Office 25 Ryder Street London SW1 England	01-930 6700	Dunlop London SW1				
Dynaflex Ltd *Dynaflex Division* North West House 119–127 Marylebone Road London NW1 England	01-262 5010		28694	Servicing equipment for plant and vehicle maintenance	314–315	
EMI Electronics Ltd *Military Division* Hayes Middlesex England	01-537 3888	Emidata London	22417	*Cymbeline* mortar-locating radar Reconnaissance pod for aircraft mounting	224–225 408–409	
H Edgard & Sons (London) Ltd PO Box 22 Whitehaven Cumberland England	Whitehaven 2441			Uniforms for all services	694–695	
Ekco Avionics *A Division of Pye Telecommunications Ltd* Southend-on-Sea Essex SS2 6PW England	Southend-on-Sea 49491	Ekco Southend	99167	Airborne radar Miss-distance system	394–395 536–537	
Electric Power Storage Ltd *Government Marketing Division* 50 Grosvenor Gardens London SW1 England	01-730 7163	Chloridic London SW1	262038	Submarine propulsion main batteries	104–105	
Head Office EPS Ltd Clifton Junction Manchester M27 2LR England	061-794 4611	Elecstor Manchester	669087			
Electro-Medical Supplies (Greenham) Ltd Wantage Berkshire England	Wantage 4291	Galfarad Wantage		Electro-medical equipment	683	

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Electronic Associates Ltd Victoria Road Burgess Hill Sussex England	Burgess Hill 5101	Pace Burgess Hill	87183	Portable radiation meter Vehicle-installed doserate meter	174 330	Analogue, digital and hybrid computers, data-logging and data-processing equipment, precision components
Elliott Automation Radar Systems Ltd *Mobile Radar Engineering Division* Elstree Way Boreham Wood Hertfordshire England	01-953 2030		22777	Short-range ground surveillance radar Seismic detectors and intruder alarm systems IRIS infra-red intruder system	222–223 227 228	Airborne early warning radar, maritime anti-submarine radar, air landing monitoring system, interceptor/ ground-mapping and terrain-following radar, electra radar relay system, fire control radar
Elliott Flight Automation Ltd *Automatic Test Equipment Division* Rochester Kent England	Medway 44400	Elliotauto Rochester	96333	Automatic test equipment	656–659	Automatic circuit testers
Head Office Marconi House New Street Chelmsford Essex	Chelmsford 53221	Expanse Chelmsford	99201			
Erskine Laboratories Ltd Newby Scarborough Yorkshire England	Scarborough 2433	Erskinlab Scalby	52562	Design, development and production of electrical and electronic equipment	728	Electronic test gear, microwave components
Ethicon Ltd Sighthill Edinburgh Scotland	031-443 4050	Ligatures Edinburgh		Sutures, ligatures, catgut, silk and related surgical products	683	
FPT Industries Ltd The Airport Portsmouth Hampshire PO3 5PE England	Portsmouth 62391	Fireproof Portsmouth	86106	Flexible assemblies for liquid storage and flotation	732–733	Rubber mouldings and extrusions
Fairey Hydraulics Ltd Cranford Lane Heston Middlesex England	01-573 7777	Airily Hounslow	22230	Aircraft power controls Hydraulic filters	416–417	
Ferranti Ltd *Aircraft Equipment Department* South Hill Park Easthampstead Bracknell Berkshire England	Bracknell 4202		84117	Gyro-stabilised sight for vehicle-borne weapons Flight instruments and helicopter auto-stabiliser	241 428–429	Compass systems, transistorised control/ invertor units, transformer rectifiers, voltage regulators, VTOL flight systems, research and development
Digital Systems Department Western Road Bracknell Berkshire RG12 1RA England	Bracknell 3232		84117	CAAIS computer-assisted action information system Data handling and weapon control system for naval applications FM1600B microminiature computer	126–127 128–129 130–131	Air traffic control systems, air defence systems, tactical control and action data automation systems, digital data transmission equipment message collection and switching systems, simulators and trainers
Electronic Systems Department Ferry Road Edinburgh EH5 2XS Scotland	031-332 2411		72141	Radar systems for aircraft and mobile ground use INAS inertial systems for aircraft navigation and attack ISIS weapon sighting systems Laser ranger and marked target seeker Head-down display	396–397 398–399 400 401 402	Radarscope recorders, lightweight inertial platforms, floated and non-floated rate gyroscopes, rate integrating gyroscopes, two-axis vertical gyroscopes, air stream direction indicators, angle of attack systems, measuring and gauging systems, control systems for satellite aerials
Government Contracts Department Hollinwood Lancashire England	061-681 2000		66342	Trainers and simulators	538–539	
The Ferrograph Co Ltd The Hyde Edgware Road Colindale London NW9 England	01-205 2241	Britferro London NW9		Magnetic tape audio recording equipment	534, 673	Marine echo sounders, transformers, endless-loop magnetic tape cassettes, switches, magnetic tape head defluxers

Name and address	Telephone	Cables	Telex	Products described	Page	Other products made
Flexibox Ltd Nash Road Trafford Park Manchester M17 1SS England	061-872 1477		66284	Flexible couplings for marine main propulsion machinery Mechanical seals for all types of rotating shaft equipment	163 743	
Flight Refuelling Ltd Wimborne Dorset England	Wimborne 2121	Refuelling Wimborne	41247	Fuel systems and associated equipment Refuelling systems for aircraft and helicopters Aerial target systems	418–419 420–421 540–541	
Fodens Ltd *Marine Department* Elworth Works Sandbach Cheshire England	Sandbach 3244	Fodenway Sandbach	36163	Diesel engines for marine propulsion, power and industry	564–565	
Francis Searchlights Ltd Turner Bridge Bolton Lancashire England	Bolton 27196	Francis Bolton		Searchlights for all purposes	744	
Thomas French & Sons Ltd 59 St James's Street London SW1 England	01-629 7101	Rufflette London SW1	25115	Airborne rocket launchers	378–379	Cartridge belts, links and clips
Head Office PO Box 22 Chester Road Manchester 15 England	061-834 1887	Rufflette Manchester	66254			
Fuller, Lucas & Co Ltd Crowborough Cross Eridge Road Crowborough Sussex England	Crowborough 2000	Lucas Crowborough	Lucas Crowborough Chamcom London 261981	Capstan winches	262–263	
GEC-AEI Telecommunications Ltd *Transmission Division* PO Box 53 Coventry CV3 1HJ England	Coventry 52152	Springjack Coventry	31361	Fixed-link lines for telephony, telegraphy and video communications	478–479	Telephone switching equipment for automatic or manual exchanges of any size, telephone switching networks, nationwide dialling systems, private telephone systems PAX/PABX, telephone instruments, open-wire and balanced-pair and coaxial cable line telephony transmission systems
GKN Sankey Ltd *Automotive and Manufacturing Division* Hadley Castle Works Wellington Shropshire England	Wellington 4321		35248	Armoured vehicle for personnel carrying and other duties	200–201	Pressed steel wheels, chassis frames, vehicle cabs, presswork panels, bumper bars, agricultural implements, automatic vending machines, pressed steel radiators, steel laminations for electric motors, plastics mouldings, tungsten carbide dies, steel furniture, partitioning, metal framing, shelving systems, office machines
Gallay Ltd Denington Industrial Estate London Road Wellingborough Northamptonshire NN8 2QU England	Wellingborough 4801			Cooling systems for military vehicles	316–317	
The Glacier Metal Co Ltd Alperton Wembley Middlesex HA0 1HD England	01-997 6611	Glamet Wembley	936881	Ships' line shaft bearings	166	Dry, lubricated and pre-lubricated plain bearings, centrifugal filters, rod end joints

Name and address	Telephone	Cables	Telex	Products described	Page	Other products made
Gloster Saro Ltd *Vehicle Division* Hucclecote Gloucester GL3 4AD England	Gloucester 67411	Glosaro Gloucester	43134	Aircraft refuellers	446	Fire-fighting equipment for aircraft, de-icing vehicles for aircraft, demineralised-water vehicles, liquid-carrying tanker vehicles, glassfibre-reinforced plastics tankers and containers
London Office Hawker Siddeley Holdings Ltd 18 St James's Square London SW1 England	01-930 2064	Hawsidair London SW1	24665			
Graviner (Colnbrook) Ltd Poyle Mill Works Colnbrook Slough Buckinghamshire England	Colnbrook 3245	Crashfires Colnbrook	84124	Fire-protection equipment	618–619	Marine monitoring systems, temperature controllers
Greengate & Irwell Rubber Co Ltd *Coated Fabrics Division* Greengate Manchester Lancashire M60 3EA England	061-834 5652	Para Manchester 5	66762	Airfield membranes for temporary runways and helicopter pads	441	Coated fabrics, conveyor belting, electric cables, engineering rubbers, industrial hose, protective clothing, transmission belting
London Office Stephenson Street Canning Town London E16 England	01-476 3222		21758			
HML (Engineering) Ltd St John's Road Isleworth Middlesex England	01-560 3011		933887	Servicing trolleys for aircraft hydraulic systems Custom-built hydraulics for equipment and systems testing	443 669	
Head Office 466–490 Edgware Road London W2 England	01-723 0022					
HTS Management Consultants Ltd 29 St James's Street London SW1 England	01-839 2822	Airtrain London SW1		Support training	708–709	
John Hadland (Photographic Instrumentation) Ltd Newhouse Laboratories Bovingdon Hertfordshire England	Hemel Hempstead 2303	Johhadland London	82344	Ultra-high-speed camera for projectile and explosives research	660–661	*Hycam* high-speed cameras, photographic instrumentation, portable film processors, aerial reconnaissance flash
A W Hainsworth & Sons Ltd Spring Valley Mills Farsley Pudsey Yorkshire England	Pudsey 3091	Army Pudsey		Uniform cloths	699	
Halmatic Ltd Havant Hampshire PO9 1JR England	Havant 6161			Patrol and rescue craft	90	Fishery protection vessels, hydrographic survey vessels, crew boats, work boats, customs launches, pilot boats, police launches
London Office 179 Piccadilly London W1 England	01-499 8341	Deborine London W1				
Harbormaster Ltd *Sales Department* Central Road Temple Fields Harlow Essex England	Harlow 34301	Jonwhiteng Harlow	81317	Outboard propulsion units	156–157	
Hawker Siddeley Aviation Ltd Richmond Road Kingston upon Thames Surrey England	01-546 7741	Hawsidair Kingston upon Thames	23726	*Buccaneer, Harrier, Hunter* aircraft HS 748, *Andover, Argosy* aircraft *Nimrod, Shackleton,* HS 125 aircraft *Vampire, Venom, Vixen* aircraft	348–349 350–351 352–353 354–355	*Comet* and *Trident* jet airliners; A300B European airbus jointly with Sud Aviation and Deutsches Airbus; *Dove* twin-engined executive transport; *Heron* four-engined executive transport; *Gnat* single-seat fighter; *Gnat* advanced trainer
London Office 18 St James's Square London SW1 England	01-930 2064	Hawsidair London SW1	24665			

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Hawker Siddeley Dynamics Ltd Manor Road Hatfield Hertfordshire England	Hatfield 62300		22324	Infra-red linescan Guided missiles	414 458–459	
London Office 18 St James's Square London SW1 England	01-930 2064	Hawsidair London SW1	24665			
Helio Mirror Co Ltd Crabtree Manorway Belvedere Kent England	Erith 32142	Scodil London W1	265403	Periscopes and cupolas for fighting vehicles	242	
Helmets Ltd Wheathampstead St Albans Hertfordshire England	Wheathampstead 2221			Flying, parachute instructor's and fire-protection helmets	696–697	
Henley Forklift Co Ltd Newbridge Road Industrial Estate Pontllanfraith Blackwood Monmouthshire NP2 2XF Wales	Blackwood 2671		49655	Fork lift trucks	632–633	
Hestair Sherpa Ltd Southall Lane Hounslow Middlesex England	01-573 3844	Hestairco Hounslow		Fork lift trucks	644	Containers
London Office 1 Buckingham Palace Mansions London SW1 England	01-730 9934					
Honeywell Ltd *Test Systems Division* Eaton Road Hemel Hempstead Hertfordshire England	Hemel Hempstead 2141	Honeywell Hemel	82165	Field test console for *Clansman* radio communications system	662–663	Digital/analogue computers, process automation, temperature controls, micro switches
Head Office Great West Road Brentford Middlesex England	01-568 9191	Honeywell Hounslow	22765			
Hunting Engineering Ltd *Defence Sales* Reddings Wood Ampthill Bedfordshire England	Ampthill 3431	Huneng Ampthill	82105		380-381	Research, design, development in air armament, military and civil aviation; development and production of electronic control equipment for automated processes
Hy-Mac Ltd Hy-Mac House Bath Road Newbury Berkshire England	Newbury 2205	Hymac Newbury	84557	Excavators and cranes	274–275	Inspection platforms, wheel-mounted cranes, crawler-mounted cranes truck-mounted cranes
The Hymatic Engineering Co Ltd *Aerospace and Advanced Products Division* Glover Street Redditch Worcestershire England	Redditch 63621	Hymatic Redditch	33634	Cryogenic coolers for infra-red devices	747	Aircraft pneumatic control valves, fuel pressurisation equipment, waveguide pressurisation equipment
Hyster Ltd Turriff Building Great West Road Brentford Middlesex England	01-568 9292			Lift trucks	634–635	
IBIS Engineers Ltd PO Box 23 Ibis Works Shap Road Kendal Westmorland England	Kendal 22621	Ibis Kendal Telex	6580	Mobile laundry	686–687	Garment presses, washing machines, drying machines, vacuum units
IPL (Gardener) Ltd *Government Marketing Division* Codex House Willow Grove Chislehurst Kent BR7 5DA England	01-467 5633			Technical documentation for the armed services	724	

Name and address	Telephone	Cables	Telex	Products described	Page	Other products made
Inspection Instruments (NDT) Ltd 10–12 Emerald Street London WC1 England	01-242 6105	Maygain London WC1		Endoscopes for visual inspection in confined spaces	670	
International Aeradio Ltd Aeradio House Hayes Road Southall Middlesex England	01-574 2411	Intaerio Southall	24114	Aeronautical charts Control systems for large communications centres Aviation services	Facing 432 516–517 710–711	Voice communications systems, telegraph and data systems, air traffic control systems, synthetic trainers, commercial printing in monochrome and colour for airlines
International Computers Ltd *Defence Area* Victoria House Southampton Row London WC1 England	01-405 7866			Electronic computers	518–519	Computer analysis equipment, computer stationery
Head Office ICL House Putney London SW15 England	01-788 7272		21159			
Irving Air Chute of GB Ltd Letchworth Hertfordshire England	Letchworth 6262	Irvin Letchworth	82198	Automatic releases for parachutes	426	Parachutes, car belts, lifting slings, cargo securing equipment, industrial safety harnesses, air cargo equipment, textile covers and structures
JCB Sales Ltd Rocester Uttoxeter Staffordshire ST14 5JP England	Uttoxeter 3121	Earthmover Uttoxeter	36154	Excavators, loaders and shovels	276–277	
London Office 4–6 Deanery Street London W1Y 5LH England	01-499 6744		266361			
Jane's Yearbooks BPC Publishing Ltd 49 Poland Street London W1A 2LG England	01-437 0686		23451	International annual reports	725	Scientific and technical books
Joyce, Loebl & Co Ltd Princesway Team Valley Gateshead Co Durham NE11 0UJ England	Gateshead 877891	Jayell Gateshead	53257	Laboratory automation systems	683	Densitormeters, sensitometers, flying-spot scanners, image quantizers, isodensitracers, tristimulus spot colorimeters, chromoscan thin layer attachments, LV units, lenses, prisms, mirrors
London Office Joyce, Loebl International Investment Sales Ltd 2 Noble Corner Great West Road Heston Middlesex England	01-570 7313					
Kelvin Hughes New North Road Hainault Ilford Essex England	01-500 1020	Marinst Ilford	896401	Radar, racon, sonar and photographic equipment	114–115	
London Office St Clare House Minories London EC3 England	01-481 8741	Marinst Phone London	262776			
L R Industries Ltd North Circular Road Chingford London E4 England	01-527 2377	Lonrubmanf London E4	21644	Sterile surgical gloves	680	Re-usable surgical gloves finger cots, condoms, general-purpose rubber gloves
Lansing Bagnall Ltd Kingsclere Road Basingstoke Hampshire England	Basingstoke 3131	Bagnallic Basingstoke	85120	Fork lift and pallet trucks Fork lift truck and towing tractor	636–637 638–639	
Samuel Lee-Bapty Ltd Cow Lane Garston Watford Hertfordshire England	Garston 73055			Special-purpose mechanical and electro-mechanical equipment	728	Thermostats, clocks, switches

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J E Lesser (International) Ltd JEL House Staines Road Hounslow Middlesex England	01-570 7755	Jell Hounslow	936161	Mobile or prefabricated quarters	688	
Leyland Motors Ltd *Military Sales Division* Berkeley Square House Berkeley Square London W1 England	01-499 6050	Leymotors London W1 Telex	22498	*Beaver* haulage chassis for airfield refuellers Multi-fuel engine	447 566–567	
Link-Miles Ltd Churchill Industrial Estate Chartwell Road Lancing Sussex England	Lancing 5881		87165	Flight simulators and trainers, visual display systems, tank driving simulators	557	
R A Lister & Co Ltd Dursley Gloucestershire GL11 4HS England	Dursley 2371	Machinery Dursley	43156	Industrial and marine diesel engines	576	Mechanical handling equipment, horse clippers
Lonsdale & Bartholomew Technical Ltd 86–88 Edgware Road London W2 England	01-723 8001			Documentation to ensure maximum utilisation of equipment	726	
Lucas Gas Turbine Equipment Ltd Shaftmoor Lane Birmingham 28 England	021-777 3232	Luset Birmingham	338781	Fuel systems and combustion and hydraulic systems	422–423	
Joseph Lucas (Batteries) Ltd Formans Road Birmingham 11 England	021-777 3292	Lucasbatt Birmingham	33105	Lead-acid storage batteries	318–319	
Joseph Lucas (Electrical) Ltd *Contract Department* Great King Street Birmingham 19 England	021-554 5252	Lucas Birmingham Telex	338681	Ignition and lighting equipment for vehicles	320–321	
MB Metals Ltd *Armament Division* Victoria Road Portslade Sussex BN4 1YH England	Brighton 46981	Metals Portslade	87311	Weapon mountings for aircraft	388–389	Data logging control equipment, cables and moulded connectors, fuzing units, aircraft switches, film-wiring harnesses for aircraft
The MEL Equipment Co Ltd Manor Royal Crawley Sussex England	Crawley 28787		87267	Infra-red sights Mobile HF radio equipment	245 480–481	
MacTaggart, Scott & Co Ltd Station Ironworks Loanhead Midlothian Scotland	Loanhead 311	Valve Loanhead	72478	Naval hydraulic equipment	168–169	Davits, replenishment-at-sea winches and masts, hoists, cranes, hydroplanes, hydraulic controls and complete systems
Marconi Communication Systems Ltd *Radio Communications Division* Marconi House Chelmsford Essex England	Chelmsford 53221	Expanse Chelmsford	99201	Military radio systems Naval radio systems	482–483 506	Data transmission and digital communications systems, pulse code modulation systems, sound broadcasting and television systems
London Office 34 Portland Place London W1 England	01-580 5522	Expanse London W1	25111			
Marconi Radar Systems Ltd Crompton Works Chelmsford Essex England	Chelmsford 67111	Marstor Chelmsford	99108	Air defence radar	470–471	
New Park Leicester LE3 1UF England	Leicester 87133	Assocelect Leicester	34551	Naval radar systems	122–123	
AEI Control Engineering Department New Parks Leicester LE3 1UF England	Leicester 871331	Assocelect Leicester	34551	Naval control equipment for power supplies and other systems Gun control equipment for fighting vehicles	132–133 244	Complete naval control systems, temperature scanning equipment, high-power ac motor drives, clutch servos, searchlights

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Marconi Space & Defence Systems Ltd *Headquarters* The Grove Warren Lane Stanmore Middlesex England	01-954 2311	Electronics Stanmore	22616	Underwater weapons and tracking ranges Weapon electronic systems Communications systems for all armed services	98 466 484–485	Space satellites, military data systems, space guidance and stabilisation, electronic components, electronic counter measures, control and instrumentation, weapon guidance
Instrumentation Group Chobham Road Frimley Camberley Surrey England	Camberley 63311	Elliotauto Camberley	85289	In-flight data recorder	432	
Military Division Chobham Road Frimley Camberley Surrey England	Camberley 63311	Elliotauto Camberley	85289	FACE computer system for artillery fire control AMETS artillery meteorological survey	226 243	
Naval Division Chobham Road Frimley Camberley Surrey England	Camberley 63311	Elliotauto Camberley	85289	Navigational computer and other data processing systems	137	
Trainer and Simulator Division Chobham Road Frimley Camberley Surrey England	Camberley 63311	Elliotauto Camberley	85289	Naval simulators for action and engine room training Flight simulators	554 555	
Marine Exploration Ltd Marex House High Street Cowes Isle of Wight England	Cowes 4731	Marex Cowes	86262	Diver transport vehicles	92–93	Diving equipment, small surface support craft, consultancy in marine activities, operational and design studies
Marshall of Cambridge (Engineering) Ltd Airport Works Cambridge CB5 8RX England	Cambridge 56291	Marfly Cambridge	81208	Vehicle bodies for military and civil applications	322–323	Design modification and repairs of aircraft and installation of interior fittings
Marston Excelsior Ltd Wobaston Road Fordhouses Wolverhampton Staffordshire WV10 6QJ England	Fordhouses 3361	Marex Wolverhampton	33211	Heat exchangers, flexible fuel tanks Heat exchangers, flexible tanks and radomes for aircraft Flexible reservoirs and armament packs	330 427 652	
Martin-Thomas Ltd *Aviation Division* South Way Walworth Industrial Estate Andover Hampshire England	Andover 4014	Hiway Andover	47277	Staging and docking system for aircraft maintenance	444	Hydraulic access platforms, mobile servicing step kits
Mercury Airfield Equipment Ltd Woodbridge Works Guildford Surrey England	Guildford 71271	Mercury Guildford	85211	Aircraft and cargo handling trucks	445	
Merryweather & Sons Ltd Greenwich High Road London SE10 England	01-692 1016	Merywether London SE10		Fire protection vehicles, installations and equipment	622	
F G Miles Engineering Ltd Riverbank Works Old Shoreham Road Shoreham-by-Sea Sussex BN4 5FL England	Shoreham-by-Sea 4511		87466	Weapon release and weapon check-out equipment	390–391	Braking force trailer, gas turbine generator sets, gas turbine water pumps, gun control equipment, service test equipment, electronic installations
Millbank Technical Services Ltd Luke House 4 Abbey Orchard Street London SW1 England	01-222 1145	Milltech London SW1	915623	Technical support services	712–713	
C S Milne & Co Ltd Harley Works Deptford London SE8 England	01-692 3252	Acetyweldo London SE8		Gas welding, cutting, brazing and soldering equipment	267	Profile cutting machines

Name and address	Telephone	Cables	Telex	Products described	Page	Other products made
Ministry of Defence Director of Sales (Army) St Christopher House Southwark Street London SE1 England	01-928 7999			*Chieftain* battle tank 105 mm light gun *Rarden 30* automatic cannon 81 mm medium mortar 81 mm medium mortar ammunition *Bren* machine gun conversion to NATO ammunition Bar mines and mine-laying equipment *Trilux* night sight Single- and double-storey medium girder bridges *Eager Beaver* rough-terrain fork lift tractor After-sales service for British military vehicles and engineer equipment	178–179 206–207 210–211 212–213 214–215 216–217 218–219 234–235 254–255 640–641 714–715	
Hydrographic Department Taunton Somerset England	Taunton 7900	Creechup Taunton		Charts	Facing 136	
Ministry of Technology *Department EIR 2* Stuart House 23–25 Soho Square London W1 England	01-437 9288	Mintec London Telex	22241	2-inch rocket system	382–383	
Morane Plastic Co Ltd Gresham Road Staines Middlesex England	Staines 51985	Morane Staines	23917	Security and protective film laminating equipment for identification cards and printed matter	747	Hot presses for dry mounting, dry mounting tissue, self-adhesive plastic films, plastic bookjackets
Morgan & Grundy Ltd *Medical Division* Cowley Uxbridge Middlesex England	Uxbridge 38551	Grundylab Uxbridge	21126	Hospital laboratory and dispensary furniture and fume extraction systems	684	
Muir-Hill Ltd Bristol Road Gloucester GL1 5RX England	Gloucester 2148	Muirhill Gloucester	43179	Multi-purpose military loading shovel	278–279	
J Nesbit-Evans & Co Ltd Wednesbury Staffordshire England	021-556 1511	Hospitabed Wednesbury		Hospital beds and ward equipment	684	
Nuclear Enterprises Ltd Sighthill Edinburgh EH11 4EY Scotland	031-443 4060	Nuclear Edinburgh	72333	Radiation monitors	676–677	Industrial and process control systems, laboratory instruments, nucleonic instruments, radiation detectors
Optical Measuring Tools Ltd Water-Ma-Trout Road Helston Cornwall England	Helston 2366		45295	Optical elements and rotary indexing tables	734–735	
Pains-Wessex Ltd High Post Salisbury Wiltshire England	Middle Woodford 282	Painwessex Salisbury		Hand-held rockets Distress signalling and rescue devices Bird-scaring cartridges, smoke and other devices	602–603 604–605 606–607	
Perkins Engines Ltd Peterborough PE1 5NA England	Peterborough 67474	Perkoil Peterborough Telex	32132	Multi-purpose diesel engines	568–569	
The Permutit Co Ltd Pemberton House 632–652 London Road Isleworth Middlesex England	01-560 5199	Permutit Hounslow	24440	Water purifying units for desalination and de-ionisation	745	Water and effluent treatment plant, sewage treatment plant, ion exchange resins, water softeners, marine condensate polishing plant
Petters Ltd *Diesel Division* Staines Middlesex England	Staines 51333	Diesel Staines Telex	23871	Diesel engines	570–571	Air compressors, diesel-powered generating sets, marine diesels, transport refrigeration units
Pilchers (Merton) Ltd Victoria Road Burgess Hill Sussex England	Burgess Hill 5707	Ambulap Burgess Hill	87323	Military ambulance	288–289	Mobile blood collecting units, mobile clinics, dispensaries and dental clinics, mobile laboratories, mobile laundries, mobile operating theatres

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Pilkington Perkin-Elmer Ltd Glascoed Road St Asaph Flintshire Wales	St Asaph 3301	Optical St Asaph	61291	Optical systems	746	Moving map displays, lasers, computer doors and optics, aircraft camera windows, missile nose cones, heat-resistant filters
Planetron (Operations) Ltd 419 Richmond Road St Margarets Twickenham Middlesex England	01-892 8854			Operating, maintenance and training manuals	716–717	
The Plessey Co Ltd *Automation and Transmission Divisions* Sopers Lane Poole Dorset England	Poole 5161		41272	Radiation alarm system for ships and submarines Telegraphy equipment	170–171 520–521	
Electronics Group Ilford Essex England	01-478 3040		23166	Torpedo depth presetting system *Sippican* bathythermograph, mine-hunting system Small-ship sonar Helicopter sonar unit Sound ranging system for locating artillery positions by radio Auto selector system for aircraft armament HF radio transmitter UHF and VHF radio systems HF radio sets Miniature UHF/VHF radio Radio transmitter Speech and data links for radio and telephone networks	99 106–107 118–119 120–121 246 403 486–487 488–489 490–491 492–493 507 522–523	
Plessey Radar Ltd Addlestone Weybridge Surrey England	Weybridge 47282	Plessrad Weybridge	262329	Naval radar and satellite communications systems Air defence radar for surveillance and control Radar display and data handling	116–117 472–473 474–475	
Portex Ltd Hythe Kent England	Hythe 66863	Portex Hythe Telex	96165	Medical plastics products	681	Therapeutic equipment, automatic peritoneal dialysis machine, Bristol blood warmer, Derbyshire oxygen chair
Portsmouth Aviation Ltd The Airport Portsmouth Hampshire PO3 5PF England	Portsmouth 62251	Portavia Portsmouth	86205	Machine gun pod and bomb tail units Servicing trolleys for weapons	386 392–393	Aerial photoflash, airborne mine-carrier, aircraft gun-harmonisation equipment, special-purpose ancillary weapon equipment
Price Brothers & Co Ltd *Hospital Division* Wellington Somerset England	Wellington 2216	Wool Wellington		Burns dressings	684	Divans, mattresses, pillows, polyurethane foams (for acoustic insulation, bedding, furniture packaging, etc)
London Office 18/18a Orchard Street London W1 England	01-935 0711					
Pye Telecommunications Ltd Newmarket Road Cambridge CB5 8PD England	Cambridge 61222		81166	Radio-telephone for vehicles	508	
The Pyrene Co Ltd Pyrene House Sunbury-on-Thames Middlesex England	Sunbury-on-Thames 85588		261402	Fire-fighting vehicles and equipment	620–621	
RFD-GQ Ltd Godalming Surrey England	Godalming 4122	Airships Godalming	85233	Personnel and supply-dropping parachutes Cine-target range for infantry training Air-sea rescue apparatus	424–425 542–543 598–599	All types of parachutes, aircrew safety harnesses, aircraft brake parachutes, air ventilated coveralls, lightweight collapsible stretcher

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Racal-BCC Ltd Western Road Bracknell Berkshire England	Bracknell 3244	Racal Bracknell	84166	Static, transportable and mobile radio equipment Man-portable radio equipment for field use Lightweight manpacks	494–495 496–497 498–499	Complete communication systems; communications receivers (all modes); transmitters, linear amplifiers and exciters; adaptors and ancillaries, remote control systems, radio-telephones, antenna systems, telegraph and telephone terminal equipment; portable transmitter/receivers and manpack equipment, specialised electronic systems, selective calling and privacy systems; frequency synthesisers; wideband matching transformers; data transmission and processing; high-speed data transmission systems; high-speed tape recording systems
Racal Instruments Ltd Duke Street Windsor Berkshire England	Windsor 69811	Racal Windsor	847013	Test instruments for communications equipment	664–665	
Racal-Thermionic Ltd Hythe Southampton Hampshire England	Hythe 3265	Technico Hythe	47600	Voice and data recording equipment	531	
Rank Precision Industries Ltd *Broadcast Division* Watton Road Ware Hertfordshire England	Ware 3939	Rank Ware	81415	Two-way telecommunications equipment	500–501	Homer/transponder radio beacon, airborne homing radar, military FM packset radio
Metrology Division Langston Road Debden Industrial Estate Loughton Essex England	01-508 5522	Survey Loughton	23855	Passive night sight for armoured fighting vehicles Individual weapon sight	248 249	
Rank Kershaw Industrial Division 200 Harehills Lane Leeds LS8 5QS England	Leeds 624601	Science Leeds	55162	Optical equipment for military use	247	
Reavell & Co Ltd PO Box 44 Ranelagh Works Ipswich IP2 0AE England	Ipswich 56124	Reavell Ipswich	98254	Air compressors for all classes of naval vessels	172–173	Automatic control equipment
London Office 44 Brook Street London W1 England	01-493 9444	Airdrill London W1	22105			
Recording Designs Ltd Blackwater Station Estate Blackwater Camberley Surrey England	Camberley 24622		85272	Data transmitters for underwater equipment Magnetic tape recorders Deep mobile target	109 532 544–545	Message stores, pressure transducers, data transmitters
Redifon Ltd *Communications Division* Broomhill Road London SW18 England	01-874 7281	Redifon London Telex	264029	Static, transportable and mobile radio equipment Radio equipment for naval and military communications	502–503 504–505	Point-to-point HF, marine and man-portable radio equipment; naval radio teleprinter equipment; radiobeacons; Omega receivers; EDC and data processing equipment; computers
Flight Simulation Marketing Unit Broomhill Road London SW18 England	01-874 7281	Redifon London Telex	264029	Flight simulators and trainers	546–547	
Renold Ltd Renold House Wythenshawe Manchester M22 5WL England	061-437 5221	Renold Manchester	669052	Mechanical power transmission equipment	747	
Reynolds Boughton Ltd *Vehicle Division* Bell Lane Amersham Buckinghamshire England	Little Chalfont 2666	Boughtons Amersham	83132	Heavy recovery vehicles	290–291	Special-purpose vehicles special vehicle bodies

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[illegible] Electronics (Markyate) Ltd Hicks Road Markyate St Albans Hertfordshire England	Markyate 761			Flaw detectors, rotary indexing and tilt tables for workshop and field use Battery chargers and battery capacity testers	671 736–737	
Rist's Wires & Cables Ltd Lower Milehouse Lane Newcastle Staffordshire England	Newcastle (Staffs) 561221	Rist's Newcastle Staffs	36301	Electric cables, preformed electric wiring assemblies, rigid and flexible printed circuits	747	
Rolls-Royce (Composite Materials) Ltd Avonmouth Road Avonmouth Bristol BS11 9DU England	Avonmouth 4821	Rolcom Avonmouth	44207	Aircraft stores Lightweight body armour	384–385 698	
Rolls-Royce Ltd *Aero Engine Division* PO Box 31 Derby England	Derby 42424	Roycar Derby	37645	Aircraft gas turbine engines	360–361	
Bristol Engine Division PO Box 3 Filton Bristol England	Bristol 693871	Brisidair Bristol	44185	Gas turbine and ramjet engines	362–363	
Industrial and Marine Gas Turbine Division PO Box 72 Ansty Coventry CV7 9JR England	Walsgrave-on-Sowe 3211	Roycov Coventry	31637	Marine gas turbine engines	144–145	Industrial gas turbines 4000 bhp–24 800 bhp
Motor Car Division Crewe Cheshire England	Crewe 55155	Roycru Crewe	36121	High-performance engines for military combat vehicles	572–573	Motor cars, light aircraft engines, investment castings
Oil Engine Division Shrewbury Shropshire England	Shrewsbury 52262	Roycar Shrewsbury	35171	Diesel engines for vehicles, boats, generators, compressors, etc.	574–575	
Small Engine Division Leavesden Watford WD2 7BZ England	Garston 74000	Rollsed Watford	23206	Aircraft and general-purpose gas turbine engines	364–365	Automotive transmission equipment
Head Office Moor Lane Derby England	Derby 42424	Roycar Derby	37645			
London Office 14–15 Conduit Street London W1 England	01-629 6201	Rolhead London W1	263371			
Rootes Motors Ltd *Export Sales Division* 26–40 Kensington High Street London W8 England	01-937 8077	Rootesmoti London W8	23535	*Dodge* 14-ton heavy-duty truck *Commer* 10-ton heavy-duty truck *Commer* 2-ton heavy-duty pick-up truck	292–293 294–295 296–297	
Rotax Ltd Chandos Road Willesden Junction London NW10 England	01-965 7777	Rodynalite London NW10	23662	Lightweight generating and starting systems	324–325	High-efficiency actuating mechanisms, encoders, servo motors
Special Products Group—Aircraft Equipment Division Phoenix Works Bradford 3 Yorkshire England	Bradford 65271	Rodynalite Bradford Telex	51336	15 kVA generating system	584–585	Constant-speed drives, ac and dc generators, actuators and motors, electric control and protection equipment, ground test equipment
The Rover Co Ltd Meteor Works Lode Lane Solihull Warwickshire England	021-743 4242	Rover Solihull	33156	Military ¾ ton *Land Rover* Military ½ ton *Land Rover* Lightweight air-portable *Land Rover*	298–299 300–301 302–303	
Rubery Owen & Co Ltd *Special Equipment Division* PO Box 10 Darlaston Wednesbury Staffordshire WS10 8JD England	021-526 3131	Ruberowen Telex Darlaston	338236	Military trailers	334–335	

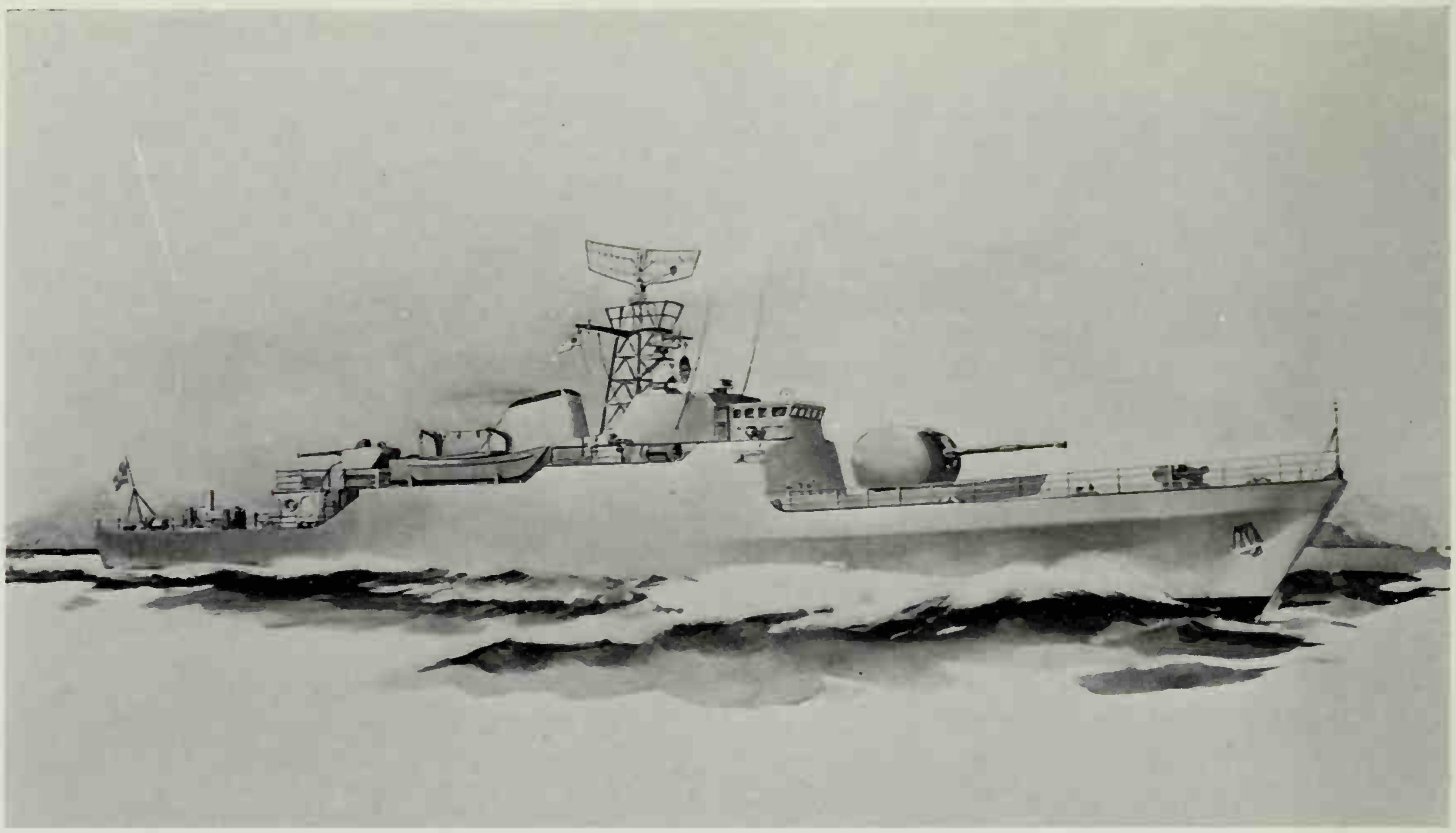
Name and address	Telephone	Cables	Telex	Products described	Page	Other products made
Ruston Paxman Diesels Ltd Vulcan Works Newton-le-Willows Lancashire England	Newton-le-Willows 5151		62366	*Ventura* diesel engines for marine propulsion Marine auxiliary diesel engines *Deltic* diesel engines for marine propulsion Stationary diesel power generating sets Transportable and mobile diesel power generating sets	146–147 148–149 150–151 586–587 588–589	
S.E.P.E.C.A.T. c/o British Aircraft Corporation Ltd Weybridge Surrey England	Weybridge 45522	Britair Weybridge	27111	*Jaguar* aircraft	356–357	
Saunders-Roe Developments Ltd North Hyde Road Hayes Middlesex England	01-573 3800	Airily London	22121	Night viewing aids	250	
Scammell Lorries Ltd *Military Sales Division* Berkeley Square House Berkeley Square London W1 England	01-499 6050	Leymotors London W1 Telex	22498	*Super Constructor* heavy-duty tractor, *Contractor* high-speed heavy-duty tractor	304–305	
Schermuly Ltd Spra Works Newdigate Dorking Surrey England	Newdigate 331	Schermuly Dorking Surrey		Rocket illuminators, flares and signals Aircraft flares and distress signals Cartridges and grenades for signalling and riot control	608–609 610–611 612–613	Rocket line-throwing equipment
Scottorn Ltd Victor Works Kingston Road New Malden Surrey England	01-942 3633	Essenn New Malden		Cargo and tanker trailers	336–337	Amphibious, generator and lubricating trailers
Self-Changing Gears Ltd *Military Sales Division* Berkeley Square House Berkeley Square London W1 England	01-499 6050	Leymotors London W1 Telex	22498	Transmissions for military vehicles	326–327	
Short Brothers & Harland Ltd *General Engineering Division* Glen Works Newtownards Northern Ireland	Newtownards 3114	Glenards Newtownards	74688	*Shorland* armoured patrol car	202	Supersonic target drones, airframes and airframe components, aircraft components, mechanical handling equipment
Missile Systems Division Montgomery Road Castlereagh Belfast BT6 9HN Northern Ireland	Belfast 59271	Predivis Belfast	74688	*Seacat, Tigercat, Blowpipe* guided missile systems	460–461	
Skyvan Division PO Box 241 Queen's Island Belfast BT3 9DZ Northern Ireland	Belfast 58444	Aircraft Belfast	74688	*Skyvan* aircraft	358–359	
London Office Berkeley Square House Berkeley Square London W1 England	01-629 9541	Broshort London W1	24934			
Thomas Smith & Sons (Rodley) Ltd PO Box BR5 Rodley Leeds LS13 2TG England	Pudsey 2844	Smith Rodley Telex	55105	Heavy-duty cranes for military and industrial uses	626–627	
The Solartron Electronic Group Ltd Farnborough Hampshire England	Farnborough 44433	Solartron Farnborough	85245	Simulators and video maps for air traffic control and defence Simulators and trainers for naval and marine use *Simfire* weapon effects simulator Digital instruments for voltage measurement and dynamic analysis	548–549 550–551 556 666–667	

Name and address	Telephone	Cables	Telex	Products described	Page	Other products made
Spembly Electronics Enham Arch Newbury Road Andover Hampshire England	Andover 5741			Near-field audio communication system	524–525	
Sperry Flight Systems Division *Sperry Rand Ltd* Downshire Way Bracknell Berkshire RG12 1QL England	Bracknell 3222	Speriflite Bracknell	84129	Flight instruments for civil and military aircraft Aeronautical instruments for navigation	430 431	
Sperry Gyroscope Division *Sperry Rand Ltd* Downshire Way Bracknell Berkshire RG12 1QL England	Bracknell 3222	Sperigyco Bracknell	84129	Naval control systems Gyroscope systems for marine navigation Vehicle navigator	134–135 136 238	
Standard Telephones & Cables Ltd *Radio Products Group* Oakleigh Road New Southgate London N11 England	01-368 1200		261912	Landing aids for airborne and ground use Aircraft communications equipment	433 533	
Head Office 190 Strand London WC2 England	01-836 8055		22385			
Stella-Meta Filters Ltd Laverstock Mill Whitchurch Hampshire England	Whitchurch (Hants) 2360	Stellameta Whitchurch Hants	85145	Water purifiers	738–739	
Stone Manganese Marine Ltd Anchor and Hope Lane London SE7 England	01-858 6171			Propellers for all marine applications	158–159	
Stothert & Pitt Ltd *Construction Equipment Division* PO Box 25 Bath Somerset BA2 3DJ England	Bath 63401	Stothert Bath	44177	Vibrating rollers for soil compaction and consolidation	280–281	Dockside cranes, deck machinery, tower cranes, concrete mixers, truck mixers, concrete batching plant, asphalt plant, pumps (rotary, screw displacement, centrifugal, lobe)
London Office 30 Buckingham Gate London SW1 England	01-222 1911		262201			
Summerfield Research Station Imperial Metal Industries Ltd Kidderminster Worcestershire England	Kidderminster 4061		33527	Rocket motor systems, solid cast double base propellants	728	
Head Office Imperial Metal Industries Ltd PO Box 216 Birmingham 6	021-356 4848		33236			
Tannoy Norwood Road London SE27 England	01-670 1131	Tannoy London SE27		Public address and crew control systems	526–527	
Technical Support & Services Ltd Route De La Haule St Brelade Jersey Channel Islands	Jersey Central 25301	Avio Jersey	41161	Technical support for defence forces	718–719	
Head Office PO Box 33 Jersey Channel Islands	Jersey Central 23527	Avio Jersey	41161			
Tektronix Ltd PO Box 36 St Peter Port Guernsey Channel Islands	Guernsey 23411		41193	Oscilloscopes	672	
Temperature Ltd 192–206 York Road London SW11 England	01-223 0511	Tetmur London SW11	28228	Environmental control systems	740–741	
Chas F Thackray Ltd PO Box 171 Park Street Leeds LS1 1RQ England	Leeds 20085		55293	Unbreakable nylon syringes Surgical instruments, hospital furniture and equipment	673 684	

Name and address	Telephone	Cables	Telex	Products described	Page	Other products made
Thorn Bendix Ltd *Industrial Electronics Division* Beech Avenue New Basford Nottingham NG7 7JJ England	Nottingham 76123		37142	Anti-submarine trainer	552–553	
Thorn Lighting Ltd *Airfield Lighting Division* Thorn House Upper Saint Martin's Lane London WC2H 9BR England	01-836 2444	Eleclampo London WC2	21521	Lighting equipment for airfields, aprons and buildings	438–439	Lamps and lighting fittings (tungsten, fluorescent, discharge)
Transport Equipment (Thornycroft) Ltd *Military Sales Division* Berkeley Square House Berkeley Square London W1 England	01-499 6050	Leymotors London W1 Telex	22498	*Nubian Major* airfield fire crash tender	623	
United Scientific Instruments Ltd Kirkman House 54a Tottenham Court Road London W1P 0BQ England	01-636 5905	Scodil London W1	265403	Lightweight mine detector Fire-control aids for ground forces	229 251	
Vauxhall Motors Ltd Luton Bedfordshire England	Luton 21122	Carvaux Luton	82131	*Bedford MK* truck	306–307	
Vickers Ltd Vickers House Millbank London SW1 England	01-828 7777	Vickers London SW1	27921	Gun mounting and aiming sights for naval guns Battle tank Mk 3 *Abbot* 105 mm self-propelled gun	140–141 180–181 204–205	
Barrow Engineering Works PO Box 12 Barrow-in-Furness Lancashire England	Barrow-in-Furness 3366	Vickerseng Barrow-in-Furness	6597	Marine diesel engines Main propulsion gearing for naval and marine vessels Guided missile launchers for *Sea Dart* and *Seawolf* Support services in shipbuilding and naval service	152–153 160–161 464–465 727	
Vickers Instruments Haxby Road York YO3 7SD England	York 24112	Coordinate York		Sights and telescopes	236–237	
Vickers Medical Engineering Basingstoke Works Priestley Road Basingstoke Hampshire England	Basingstoke 5151			Medical engineering systems	682	
Vickers Shipbuilding Group *Barrow Shipbuilding Works* PO Box 6 Barrow-in-Furness Lancashire England	Barrow-in-Furness 20351	Vicarmsea Barrow-in-Furness	6571	Escort and patrol vessels Type 42 destroyer Submersibles for underwater naval work *Oberon* diesel-electric patrol submarine Submarine weapons (missile systems, fire-control systems and torpedoes) SLAM (submarine or surface-launched air missile system)	68–69 82 94–95 96 97 462–463	
W Vinten Ltd *Aviation Equipment Division* Western Way Bury St Edmunds Suffolk England	Bury St Edmunds 2121	Vintacinni Bury St Edmunds	81176	Reconnaissance equipment for aerial photography and ground support	410–411	16 mm airborne and scientific cameras, mobile field photographic units, camera servicing vehicles
Vosper Electric *Industrial and Marine Controls Division* Castle Trading Estate Portchester Fareham Hampshire England	Cosham 79481		86115	Main machinery controls for naval vessels	164	Inverters and battery chargers, motor starters and speed controls, electronic components

Name and address	Telephone	Cables	Telex	Products described	Page	Other products made
Vosper Thornycroft *Shipbuilding Division* Vosper House Paulsgrove Portsmouth England	Cosham 79481		86115	Frigates Corvettes Diesel patrol craft Gas turbine patrol craft Maintenance and repair ship Glass-reinforced plastics launches and boats Hovercraft	70–71, 78–79 72–73 74–75 76–77 86–87 88–89 374–375	
Vosper Thornycroft Engineering *Hydraulic Power Division* Paulsgrove Portsmouth Hampshire England	Cosham 79481		86115	Ship's stabiliser	165	
Wallop Industries Ltd Middle Wallop Stockbridge Hampshire England	Wallop 456		47692	Reconnaisance flare for fixed-wing aircraft	614	Tracking flares, rocket motor igniters, pyrotechnic delay elements, pyrotechnic pressure delay units, pyromechanical actuators gas generators, power generator cartridges
Webley & Scott Ltd (*Incorporating W W Greener Ltd*) Handsworth Birmingham 21 England	021-553 3952	Webley Birmingham		Anti-riot equipment for short-range peace-keeping duties	220	Signal pistols, lightweight hydraulic jacks
Wessex Industries Ltd Market Street Poole Dorset England	Poole 2626	Industries Poole		Tractors, trucks and trailers	642–643	
Westinghouse Brake and Signal Co Ltd *Semiconductor Division* 82 York Way King's Cross London N1 England	01-837 6432	Westinghouse London N1	261629	Thyristor for pulse modulator and similar applications	534	Low, medium and high-power silicon diodes, avalanche silicon diodes fast-recovery silicon diodes, low, medium and high-power thyristors, inverse gate thyristors, fast-switching thyristors inverter grade thyristors, selenium surge suppressors, thyristor driver and controller units, power transistors, triacs
Westland Helicopters Ltd Yeovil Somerset England	Yeovil 5222	Aircraft Telex Yeovil	46277	Helicopters for military and civil duties	368–369	Precision castings and gears
London Office Westland Aircraft Ltd 8 The Sanctuary London SW1 England	01-222 4822	Aldwarke London Telex	25232			
Williamson Manufacturing Co Ltd Hawthorn Road London NW10 England	01-459 0073	Kinetogram London NW10	25842	Reconnaissance and air survey cameras X-ray processing equipment	412–413 678–679	Specialist photographic equipment
Y-ARD Ltd PO Box 4000 1395 South Street Glasgow W4 Scotland	041-959 1251	Yard Glasgow	77380	Naval consultancy (design, strategic and marine services) Naval consultancy (technical services)	720–721 722–723	
London Office 4 Abbey Orchard Street London SW1 England	01-799 2178					
Yarrow (Shipbuilders) Ltd Scotstoun Glasgow W4 Scotland	041-959 1221	Yarship Glasgow	77357	Frigates	78–81	
London Office 26 St James's Street London SW1 England	01-930 2848		262007			
Zimmer Orthopaedic Ltd 176–178 Brompton Road London SW3 England	01-584 6416	Zimorpedic London SW3		Fracture equipment, folding wheelchairs, walking aids and rehabilitation equipment	684	Implants for orthopaedic surgery, surgical instruments, traction apparatus, crutches, walking sticks, bath and toilet aids

Section 1
Ships



Principal particulars and abridged specification

Hull form
Round bilge with knuckle forward

Construction
All-welded mild steel hull with aluminium alloy superstructure

Propulsion
Triple marine diesel engines driving three screws through reverse reduction gearboxes

Performances
Triple diesel engines each rated at 4410bhp at 1900rev/min maximum rating, and 3670bhp at continuous rating
Maximum speed 24 knots
Continuous speed 22 knots
Note—Speeds given at half-load displacement in UK conditions

Range
With standard fuel load at 14 knots, 3300nm

Tank capacities
Fuel (standard) 80 tons
Fresh water 24 tons

Operational spaces
Operations room, sonar control, fire control office, wheelhouse, radar and W/T offices

Steering gear
Power steering operating twin rudders. Control from wheelhouse or emergency position aft

Radio and navigational equipment
Radar—Plessey AWS 1 and Decca TM 626
Echo sounder—Kelvin Hughes MS32F
Log—Chernikeef electronic
Compasses magnetic
Arma Brown Mk 1 gyro with repeaters
M/F and VHF transmitter/receivers
Alternative equipment can be installed to suit owners requirements

Electrical
440V 3ϕ, 60Hz
Two 200kVA diesel-driven alternators
One 40kVA harbour duty

Fire and bilge systems
Power fire main connected to pumps with fire hose connections on weather and accommodation decks
Magazine spray and portable hand extinguishers
Bilge main with suction to each main compartment

Stabilisers
Fin-type (optional extra)

General equipment
Two patent/stockless bower anchors
One kedge anchor
274m (150 fathoms) forged steel stud link cable for each bower anchor
110m (60 fathoms) 140mm (5½in) circ. Manilla towline
110m (60 fathoms) 3½in circ. FSWR towline
Two 110m (60 fathoms) 3in circ. mooring lines

Accommodation
Arranged for a total complement of 66 officers and men
Commanding officer in separate cabin
Five officers in single and double cabins
Six CPOs in separate cabins
Ten POs in separate mess
Forty-five ratings in three separate messes
All-electric galley, servery, refrigerated and provision stores
Wardroom
Separate toilet facilities for officers, petty officers and crew

Fresh-water system
Automatic pressure-type supplying all services
Hot water from 360 litre (80gal) calorifier

Ventilation and air-conditioning
All living and operational spaces air-conditioned
Mechanical supply and exhaust of fresh air to all other necessary spaces

Insulation
Accommodation, operational spaces and engine rooms fitted with heat and sound insulation material

Life saving equipment and boats
One 6·7m (22ft) glass-fibre sea boat
Two 20-man inflatable liferafts
Two 10-man inflatable liferafts
Four lifebuoys with buoyant lights
One lifejacket per man

Armament
One 114·3mm (4·5in) forward gun mounting
One 40mm gun aft mounting
One anti-submarine system
Integrated fire control system
Two 50·8mm (2in) target-illumination rocket launchers
Search and attack sonar

Corvette

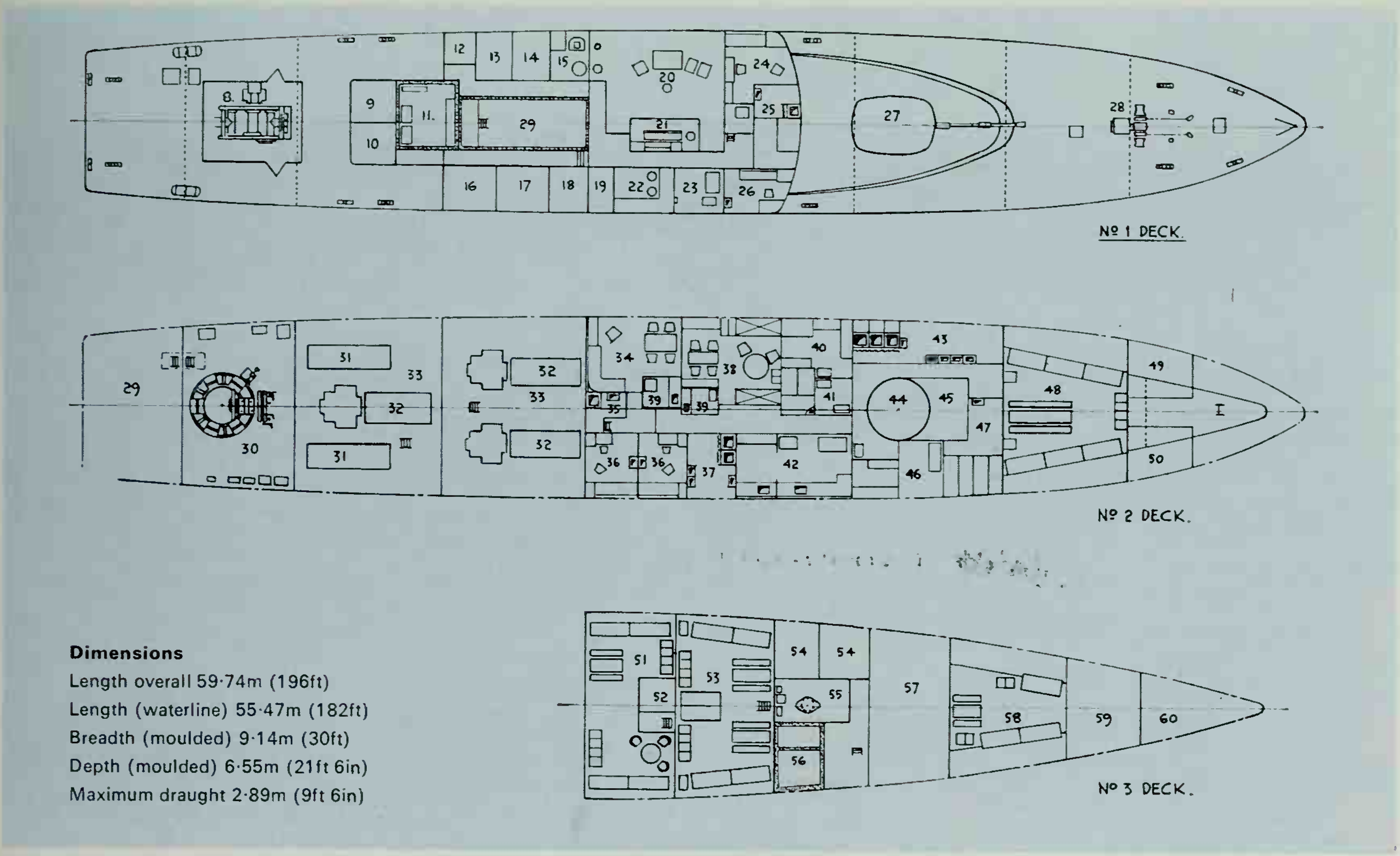
196ft triple-screw vessel

The 60m (196ft) corvette is well suited to carry out swiftly and economically a variety of roles that might otherwise require a larger and more expensive vessel.

Within the particularly handsome exterior of the corvette either a diesel or CODAG machinery arrangement can be fitted.

With a 114·3mm (4½in) fully automatic gun mounted forward, which requires limited manning, the corvette also features an anti-submarine weapon system in addition to a 40mm AA gun mounted aft.

The corvette can be adapted for any specialist purpose within the designed payload, and missile systems can be carried.

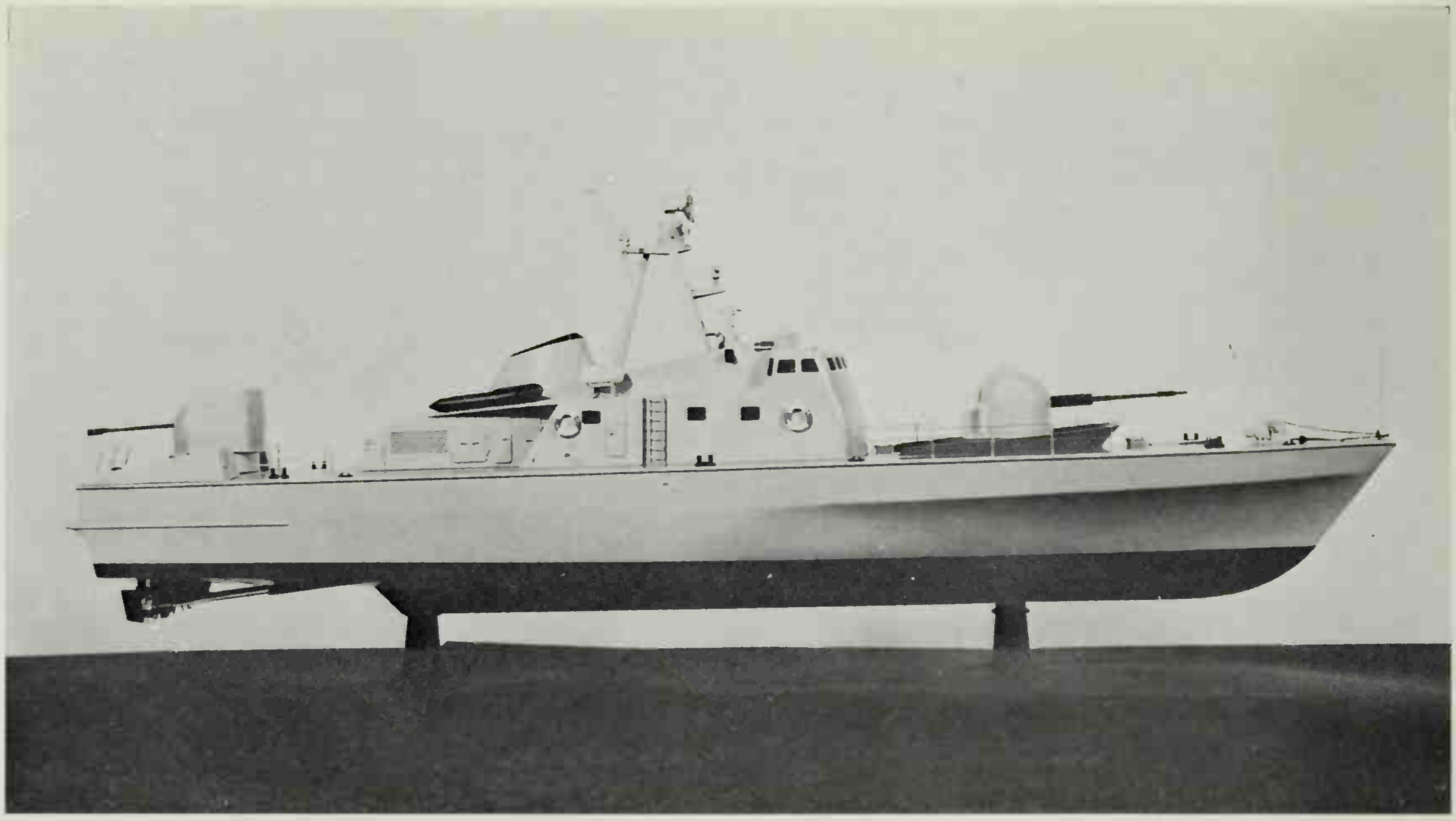


Dimensions
Length overall 59·74m (196ft)
Length (waterline) 55·47m (182ft)
Breadth (moulded) 9·14m (30ft)
Depth (moulded) 6·55m (21ft 6in)
Maximum draught 2·89m (9ft 6in)

1 40mm automatic gun mounting
2 6·7m (22ft) sea boat
3 Funnel
4 50mm (2in) rocket flare projector
5 Inflatable liferaft
6 Fire control compartment
7 Enclosed wheelhouse and chartspace
8 Anti-submarine weapon
9 40mm magazine
10 Armament store
11 Machinery control room
12 Decontamination compartment
13 Bosun store
14 Spare compartment
15 Laundry
16 Air-conditioning and ventilation compartment
17 Electrical maintenance room
18 Spare compartment
19 Special radio equipment
20 Operations room
21 Sonar control compartment
22 Wireless office
23 Radar office
24 Captain's cabin
25 Captain's toilet
26 Officers' cabin
27 114·3mm (4½in) automatic gun
28 Windlass
29 Steering compartment
30 ASW loading compartment
31 Diesel-driven alternators
32 Main engines
33 Machinery spaces
34 Wardroom
35 Officers' toilet
36 Officers' cabins
37 Petty officers' toilets
38 Chief petty officers' mess
39 Pantry
40 Ship's office
41 Sonar store
42 Galley and servery
43 Ratings' toilets
44 Gun bay
45 Handing room
46 Captain of turret office
47 Ratings' toilets
48 Ratings' mess
49 Paint store
50 Lamp store
51 Petty officers' mess
52 Gyro room
53 Ratings' mess
54 Store rooms
55 Sonar compartment
56 Refrigerated stores
57 4·5in magazine
58 Ratings' mess
59 NBCD store
60 Chain locker

BROOKE MARINE LIMITED
Lowestoft, Suffolk, England
Telephone: Lowestoft 5221 Cables: Brookcraft Lowestoft Telex: 97145

1968



Principal particulars and abridged specification

Hull form
Round bilge with knuckle forward

Construction
All-welded mild steel hull with aluminium alloy superstructure

Propulsion
Four marine diesel engines driving quadruple screws. Forward engines driving through integral gearboxes, aft engines driving through integral gearboxes and V-drives

Performance

Engines	Max. bhp (each)	Max. speed (knots)	Max. continuous speed (knots)
Four Napier Deltic CT 18-42K diesels . .	3700	40·6	34·9

Note: All speeds given at half-load displacement in UK conditions

Range
With standard fuel load at 14 knots, 1700 nautical miles. With reserve tanks at 14 knots, 2075 miles

Tank capacities
Fuel (standard) 36 tons
Fresh water 6 tons

Operational spaces
Open bridge
Wheelhouse
Operations room

Steering gear
Power-assisted mechanica operating twin spade rudders. Control from wheelhouse or bridge

Radio and navigational equipment
Radar—Decca TM 626
Echo sounder—Kelvin Hughes MS 32F
Log—Sal 59
Compasses—one magnetic, Arma Brown Mk 1 gyro
Navigator—Decca Mk 12
Main transmitter/receiver—Marconi N 3000, also UHF and VHF ship-to-ship and ship-to-aircraft transmitter/receivers, plus portable transmitter/receiver for use with assault craft
Alternative equipment can be installed to suit owners' requirements

Electrical system
440V, three-phase, 60Hz
Three 75kVA diesel-driven alternators

Fire and bilge system
Power fire main connected to pumps with fire hose connections on weather deck
Magazine spray and portable hand extinguishers
Bilge main with suctions to each main compartment
Two centrifugal-type pumps

Stabilisers
Fin-type (optional extra)

General equipment
One 136kg (300lb) Meon anchor
One 68kg (150lb) Meon anchor
110m (60 fathoms) WI stud link cable
110m (60 fathoms) 3in circ. nylon towlines
Two 110m (60 fathoms) 3in circ. mooring lines

Accommodation
Arranged for a total complement of 24
Commanding officer in separate cabin
Three junior officers in three-berth cabin
Four petty officers in four-berth cabin
16 ratings in forepeak
Additional accommodation for a further two petty officers and four ratings available for training purposes
All-electric galley with cooker, water heater, deep-freeze, refrigerator, etc
Wardroom
Separate toilet facilities for officers, petty officers and ratings

Fresh water system
Automatic pressure-type supplying all outlets
Hot water from 180 litre (40gal) calorifier

Ventilation
All living and operational spaces air-conditioned
Mechanical supply and exhaust to all othe necessary spaces

Insulation
Accommodation, operational spaces and engine room fitted with heat and sound insulation material

Lifesaving equipment and raiding craft
Two 15-man inflatable liferafts
Two lifebouys
One lifejacket per man
Two 10-man 'Z' boats with 20hp outboard motors

Armaments—schedule 1

1 **Forward position**
76mm/62 calibre compact automatic gun, with secondary 'local' control by stabilised sight

2 **Aft position**
35mm/90 calibre twin gun mounting with secondary 'local' control by on-mount sights

3 **Extreme aft**
Four fixed launchers for surface-surface guided missiles

4 **Fire control**
Fully integrated fire control system

5 **Magazines**
Forward, lower deck 76mm. Aft, main deck 35mm

Armaments—schedule 2

1 **Forward position**
35mm/90 calibre twin gun mounting with secondary 'local' control by on-mount sights

2 **Aft position**
35mm/90 calibre twin gun mounting with secondary 'local' control by on-mount sights

3 **Extreme aft**
Four fixed launchers for surface-surface guided missiles

4 **Fire control**
Fully integrated fire control system

5 **Magazines**
Forward, lower deck 35mm. Aft, main deck 35mm

Strike craft

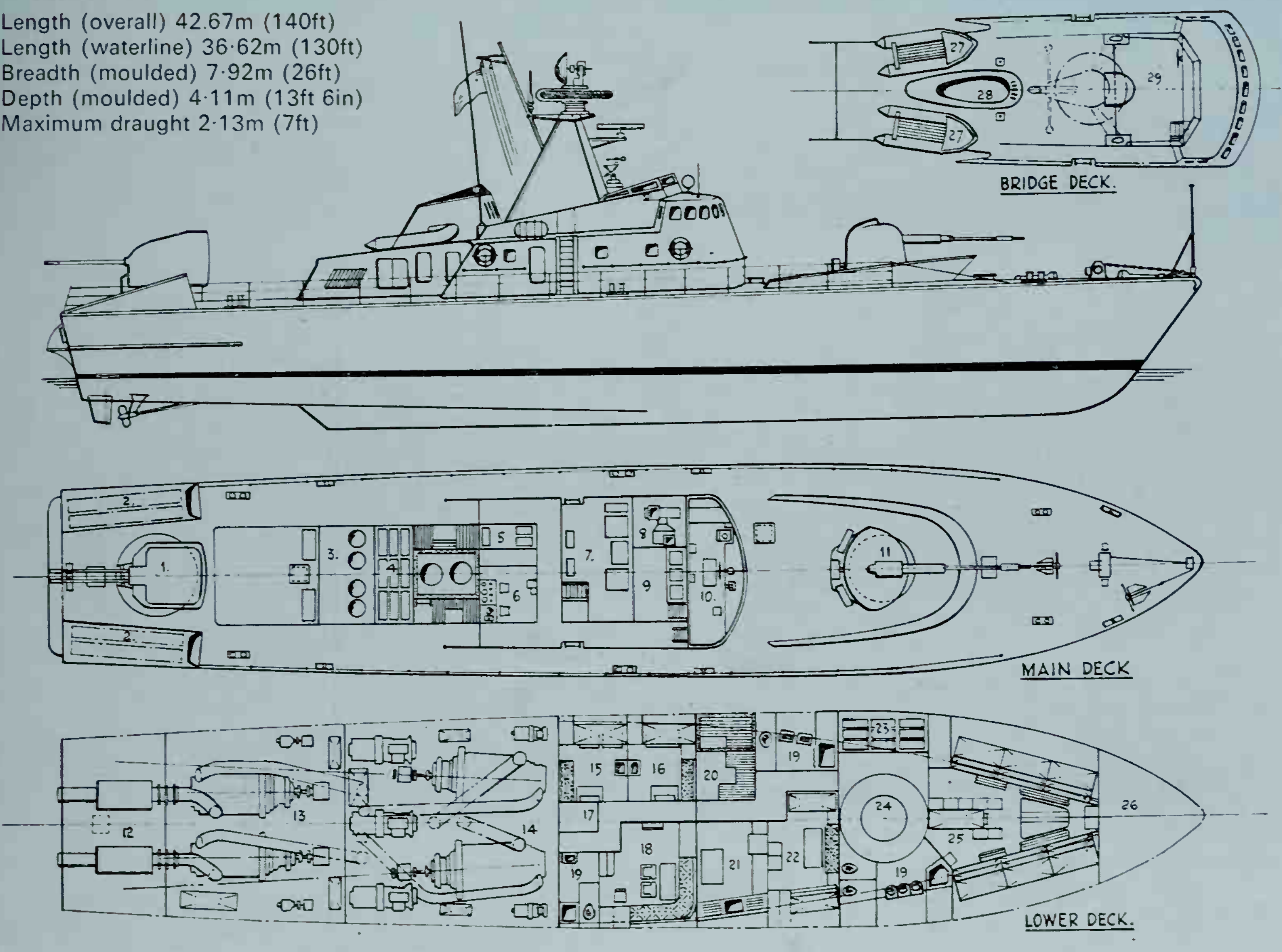
140ft quadruple-screw vessel

The 42·7m (140ft) Brooke Marine fast strike craft is a sophisticated small warship with fully integrated fire control system for surface missile system, 35mm twin gun for AA defence, and a 76mm multi-purpose gun.

With four diesel engines operating on four shafts, the 140ft has a maximum speed in excess of 40 knots. Integrated weapon system, sophisticated navigational aids, and communications equipment are fitted, giving the craft considerable offensive and defensive potential.

Dimensions

Length (overall) 42.67m (140ft)
Length (waterline) 36·62m (130ft)
Breadth (moulded) 7·92m (26ft)
Depth (moulded) 4·11m (13ft 6in)
Maximum draught 2·13m (7ft)



LEGEND

1	35mm QF twin gun
2	Missiles
3	Air filtration space
4	Magazine
5	Radar room
6	Engine control room
7	Operations room
8	Air-conditioning plant
9	W/T office
10	Wheelhouse
11	76mm gun
12	Aft peak
13	Aft engine room
14	Forward engine room
15	CO's cabin
16	Officers' cabin
17	Gyro
18	Wardroom
19	Toilet
20	Cold store and provision room
21	Galley
22	PO's mess
23	Magazine
24	Gun well
25	Crew's space
26	Fore peak
27	'Z' boat
28	Funnel
29	Open bridge

BROOKE MARINE LIMITED
Lowestoft, Suffolk, England
Telephone: Lowestoft 5221 Cables: Brookcraft Lowestoft Telex: 97145

HMAFV *Seal*

36m (120ft) twin-screw fast patrol craft

Principal particulars and abridged specification

Hull form
Round bilge with knuckle forward

Construction
All-welded mild steel hull with aluminium alloy superstructure

Propulsion
Twin marine diesel engines driving twin screws, through reverse-reduction gearboxes

Performance
Up to 33·5 knots depending on engines specified

Engines	Max. bhp (each)	Max. speed (knots)	Max. cont. speed (knots)
Twin 12YJCM Paxman	3600	23·5	21·5
Twin 16YJCM Paxman	4800	27·0	24·5
Twin T18-37K Napier Deltic	6200	30·5	27·0
Twin CT18-42K Napier Deltic	7400	33·5	29·0

Note: All speeds given at half load displacement in UK conditions

Range
With standard fuel load at 13 knots, 1800 nautical miles
With reserve tanks at 13 knots, 2500 nautical miles

Tank capacities
Fuel (standard) 20 tons
Fresh water 5 tons

Operational spaces
Wheelhouse and operations rooms

Steering gear
Power-assisted mechanical, operating twin spade rudders. Control from wheelhouse or emergency position aft

Radio and navigational equipment
Radar—Decca RM316
Echosounder—Kelvin Hughes MS32F
Log—Chernikeef electronic
Magnetic compass
Decca Arkas autopilot
Main transmitter/receiver—Pye
Alternative equipment can be installed to suit owners' requirements

Electrical system
440V, 3-phase, 60Hz; two 70kVA diesel-driven alternators

Fire and bilge system
Power fire main connected with pumps with fire hose connectors on weather deck. Magazine spray and portable hand extinguishers. Bilge main with suctions to each main compartment. Two centrifugal-type general service pumps

Stabilisers
Fin-type (optional extra)

General equipment
One 100kg (224lb) Halls anchor
One 68kg (150lb) Meon anchor
110m (60 fathoms) W1 stud link cable
110m (60 fathoms) 3in circ. nylon towline
Two 110m (60 fathoms) 3in circ. mooring lines

Accommodation
Arranged for a total complement of 25–27 depending on role
Commanding officer in separate cabin
2 officers
2 or 4 petty officers
18–22 ratings
All-electric galley with cooker, water heater, deep-freeze, refrigerator, etc
Wardroom
Separate toilet facilities for officers, petty officers and ratings

Fresh water system
Automatic pressure type supplying all outlets
Hot water from 180 litre (40gal) calorifier

Ventilation
All living and operational spaces air-conditioned
Mechanical supply and exhaust of fresh air to all other necessary spaces

Insulation
Accommodation, operational spaces and engine room fitted with heat and sound insulation material

Lifesaving equipment and raiding craft
Two 15-man inflatable lifecrafts in GFRP valises
Two lifebouys
One lifejacket per man
Two 8-man 'Z' boats with 20hp outboard motors

Patrol craft

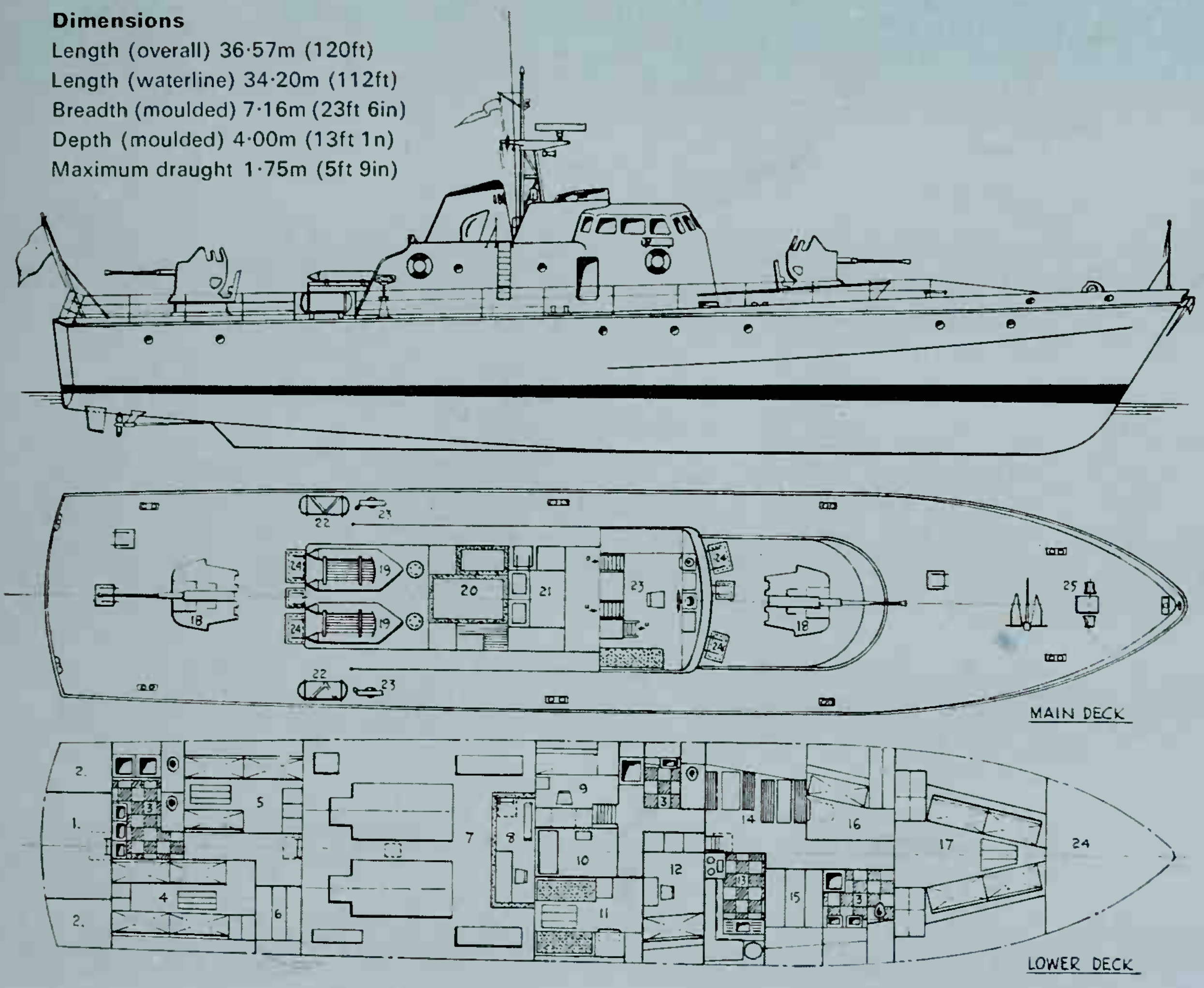
120ft twin-screw vessel

The twin-screw 36m (120ft) craft is a development of the highly successful long-range support and recovery craft designed and built by Brooke Marine for the UK Ministry of Defence (Air).

The craft has superior sea-keeping characteristics combined with high performance and long range. Sophisticated weapons systems, usually associated with larger craft, may be installed to make the craft a formidable small warship.

Accommodation and operational spaces of the highest standard are arranged to ensure that maximum crew efficiency can be maintained on long patrol missions in adverse weather conditions

Dimensions
Length (overall) 36·57m (120ft)
Length (waterline) 34·20m (112ft)
Breadth (moulded) 7·16m (23ft 6in)
Depth (moulded) 4·00m (13ft 1n)
Maximum draught 1·75m (5ft 9in)



Legend

1	Aft peak
2	Store
3	Toilet
4	Cabin—8 ratings
5	Cabin—6 ratings
6	Magazine
7	Engine room
8	Control room
9	CO's cabin
10	Elec. computer and gyro room
11	Wardroom
12	Cabin—2 officers
13	Galley
14	Crew's mess
15	Magazine
16	Cabin—2 petty officers
17	Cabin—8 ratings
18	40mm Bofors gun
19	'Z' boat
20	Engine casing
21	Operations room
22	Life raft
23	Rocket flare projector
24	'Ready use' ammo lockers
25	Windlass

Schedule of alternative armament roles
The following armament roles are submitted for guidance purposes only and within reasonable limits (depending on displacement and performance required) consideration can be given to a combination of armament selected from all roles.

ROLE 1
One 40mm gun mounting forward
One 40mm gun mounting aft
Two 2in rocket launchers

ROLE 2
One 40mm gun mounting forward
One 20mm gun mounting aft
Two 2in rocket launchers

ROLE 3
One twin 30mm gun mounting forward
One twin 20mm gun mounting aft
Four 21in torpedoes in side launchers
Two 2in rocket launchers

ROLE 4
One 40mm gun mounting forward
SU guided missile system with four fixed launchers aft
Two 2in rocket launchers

ROLE 5
One 35mm twin gun mounting forward
SU guided missile system with four fixed launchers aft
Two 2in rocket launchers

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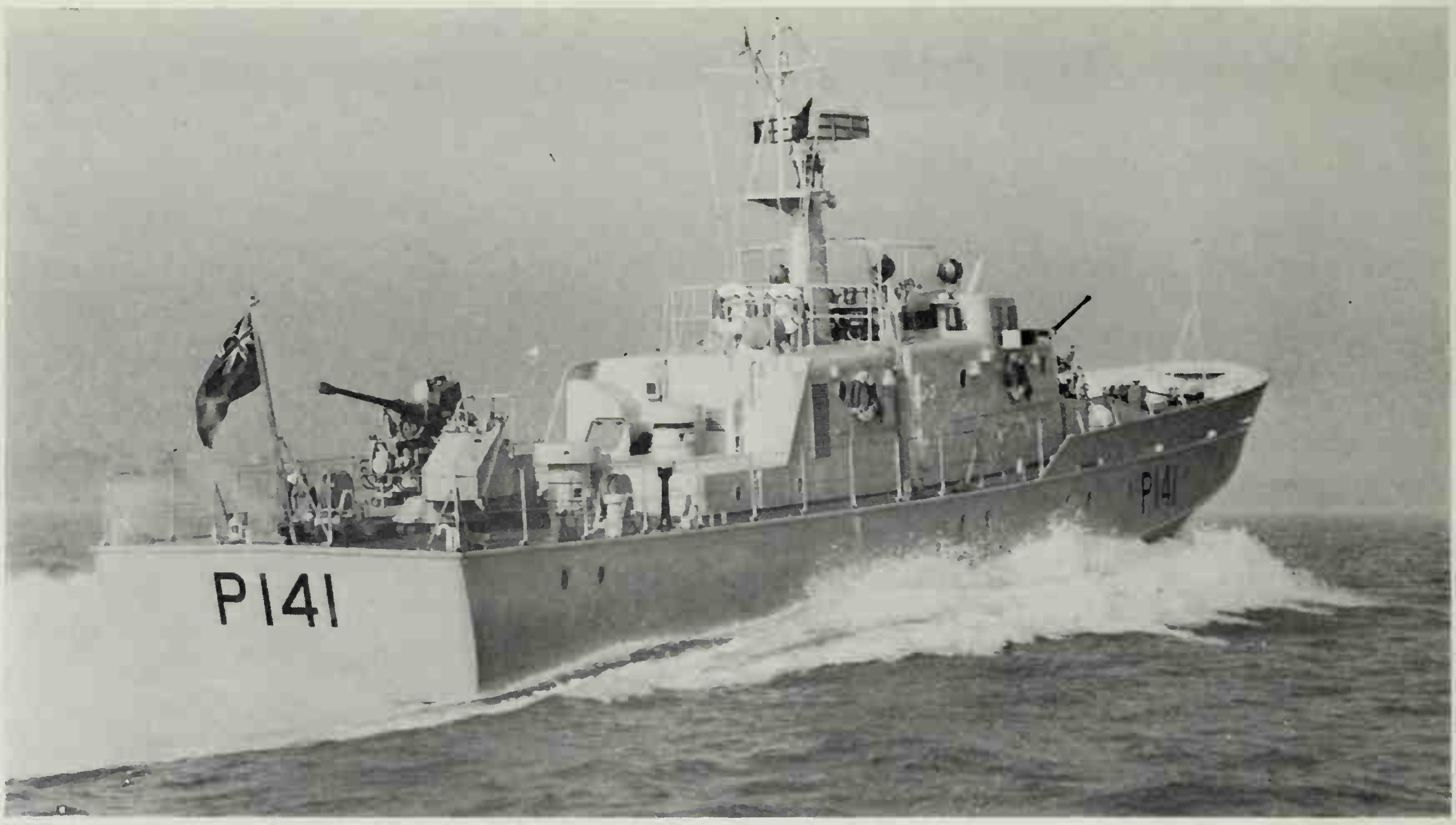
Lowestoft, Suffolk, England
Telephone: Lowestoft 5221 Cables: Brookcraft Lowestoft Telex: 97145

1968



Principal particulars and abridged specification

Hull form
Round bilge with knuckle forward

Construction
All-welded mild steel hull with aluminium alloy superstructure

Propulsion
Twin marine diesel engines driving twin screws through reverse-reduction gearboxes

Performance
Up to 26·5 knots depending on engines specified, see table for alternative installations

Engines	Max. bhp (each)	Max. speed (knots)	Max. continuous speed (knots)
Twin Paxman 12 YJCM diesels	1800	23·5	21·5
Twin Paxman 16 YJCM diesels	2400	26·5	24·0

Note: All speeds given at half-load displacement in UK conditions

Range
With standard fuel load at 12 knots, 2300 nautical miles
With reserve tanks at 12 knots, 3500 nautical miles

Tank capacities
Fuel (standard) 18 tons
Fresh water 5 tons

Operational spaces
Conning bridge
Wheelhouse
Operations room

Steering gear
Power-assisted mechanical, operating twin spade rudders. Control from wheelhouse or emergency position aft

Radio and navigational equipment
Radar—Decca RM 316
Echo sounder—Kelvin Hughes MS 32F
Log—Chernikeef electronic
Magnetic compass
Decca Arkas autopilot
Main transmitter/receiver—Pye
Alternative equipment can be installed to suit owners' requirements

Electrical system
440V, 3-phase, 60Hz
Two 60kVA diesel-driven alternators

Fire and bilge equipment
Power fire main connected to pumps with fire hose connections on weather deck
Magazine spray and portable hand extinguishers
Bilge main with suctions to each main compartment
Two centrifugal-type general service pumps

Stabilisers
Fin-type (optional extra)

General equipment
One 100kg (224lb) Halls anchor
One 68kg (150lb) Meon anchor
110m (60 fathoms) W1 stud link cable
110m (60 fathoms) 3in circ. nylon towline
Two 110m (60 fathoms) 3in circ. mooring lines

Accommodation
Arranged for a total complement of 21
Commanding officer in separate cabin
Two officers
Two petty officers
16 ratings
All-electric galley with cooker, water heater, deep-freeze, refrigerator, etc
Wardroom
Separate toilet facilities for officers, petty officers and ratings

Fresh water system
Automatic pressure-type supplying all outlets
Hot water from 180 litre (40gal) calorifier

Ventilation
Mechanical supply and natural exhaust of fresh air to all accommodation, operational spaces and toilets. Mechanical supply and exhaust to galley and engine room. Air-conditioning available if required.

Insulation
Accommodation, operation spaces and engine room fitted with heat and sound insulation material

Life-saving equipment and raiding craft
Two 12-man inflatable liferafts
Two lifebouys
One lifejacket per man
Two six-man Z boats with 20hp outboard motors

Standard armament
Forward—40mm gun
Aft—40mm gun
Two 2in rocket flare launchers
Total magazine capacity (40mm)—960 rounds

Patrol craft

107ft twin-screw vessel

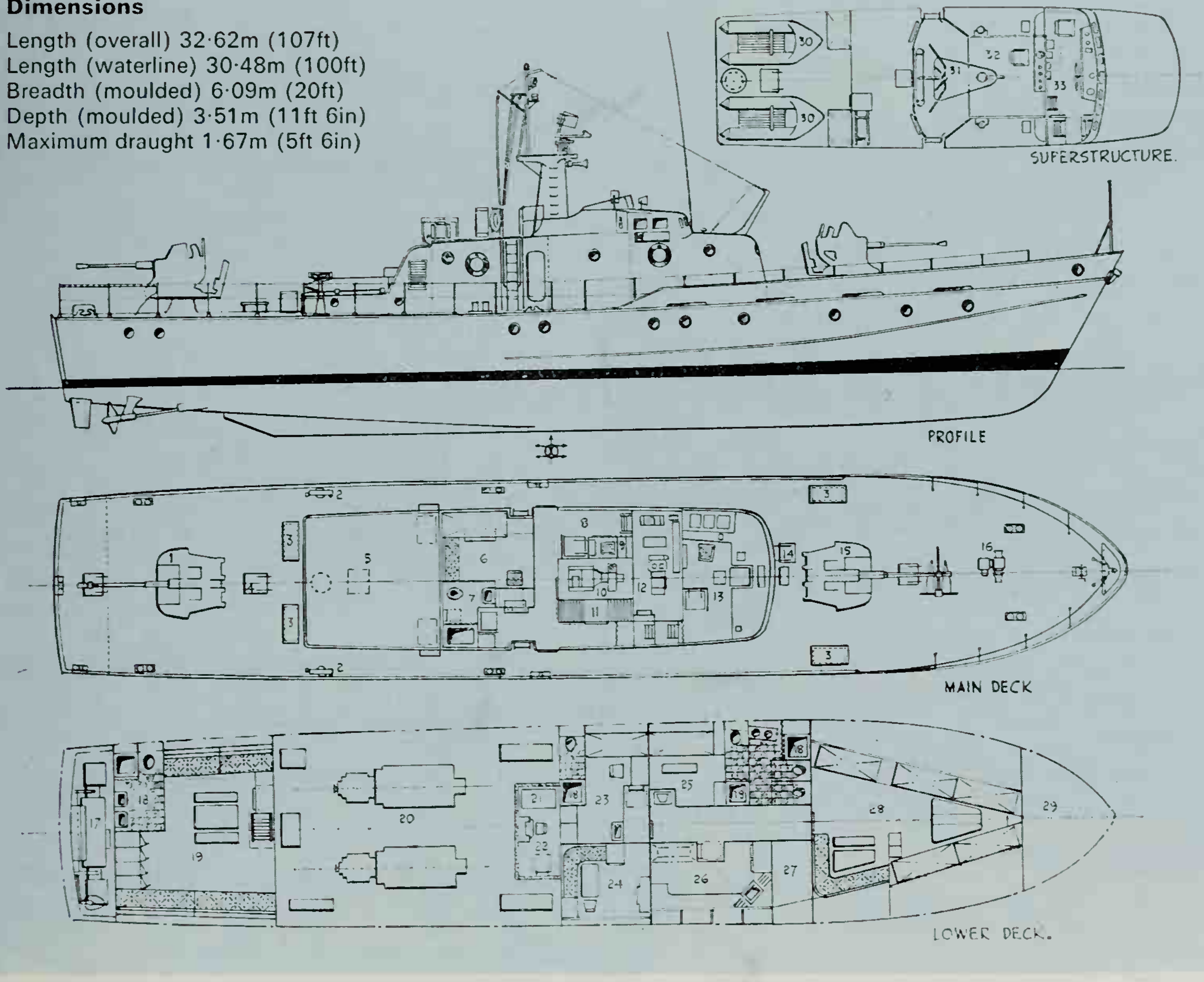
Brooke Marine's 32·6m (107ft) craft combines economy of size with functional scope. A variety of duties can be carried out by the craft depending on the armaments selected. With an all-steel hull and aluminium alloy superstructure, the 107 has excellent sea-keeping qualities, performance and reliability. The craft's sea-keeping abilities may be further improved by the installation of stabilisers. Weapon capability can be adapted to particular requirements.

Depending on the engines specified, the craft can have a maximum speed of 26·5 knots and a range of considerably more than 2000 miles, which can be further extended to 3500 miles when the reserve fuel tanks are utilised.

In common with other Brooke Marine patrol craft, the 107ft patrol craft is built to the highest standards ensuring economy of operation and maximum usefulness.

Dimensions

Length (overall) 32·62m (107ft)
Length (waterline) 30·48m (100ft)
Breadth (moulded) 6·09m (20ft)
Depth (moulded) 3·51m (11ft 6in)
Maximum draught 1·67m (5ft 6in)



LEGEND

1 40mm gun aft
2 Rocket flare projector
3 'Ready use' ammo lockers
4 Access hatch to aft accommodation
5 Engine casing
6 CO's cabin
7 CO's toilet
8 Lobby
9 Engineer's office
10 Aft air-conditioning room
11 Galley store
12 Forward air-conditioning room
13 Operations room
14 Access to accommodation forward
15 40mm gun forward
16 Windlass
17 Aft peak and steering gear compartment
18 Toilet
19 Cabin—6 ratings
20 Engine room
21 Switchboard
22 Engine control room
23 Cabin—2 officers
24 Wardroom
25 Cabin—2 POs
26 Galley
27 Magazine
28 Cabin—10 ratings
29 Fore peak
30 'Z' boats
31 Mast platform
32 Conning bridge
33 Wheelhouse

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Lowestoft, Suffolk, England
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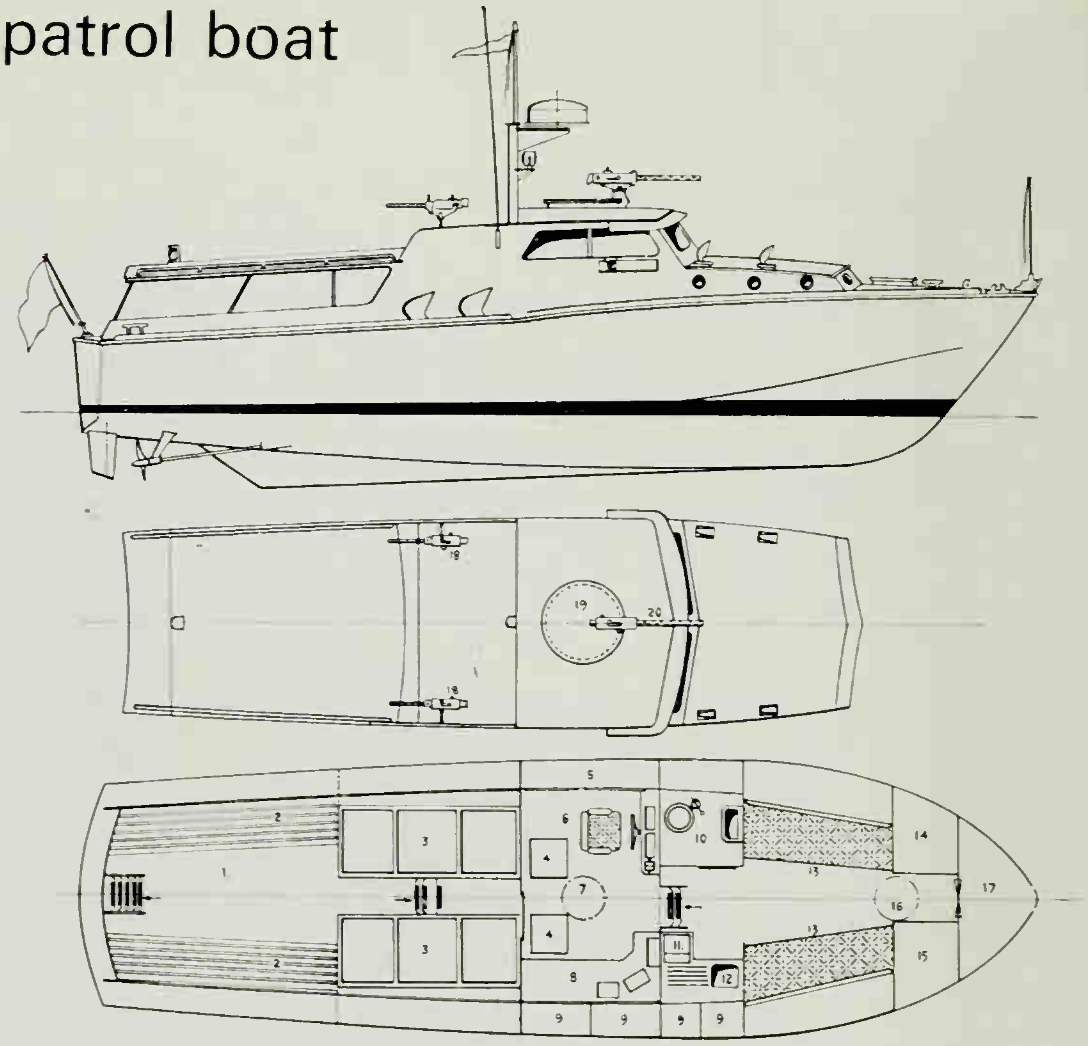
1968

12.2m (40ft) fast patrol boat

1 Aft cockpit
2 Sparred seats
3 Engine hatches
4 Flush hatch to ammunition store
5 Small arms stowage
6 Control house
7 Portable gunner's platform
8 Chart table and radio equipment
9 Cupboards
10 Toilet
11 Galley stove
12 Sink unit
13 Settee berth
14 Hanging cupboard
15 Shelf space
16 WT hatch (over)
17 Fore peak
18 Light machine gun (P & S)
19 Gunner's hatch
20 Heavy machine gun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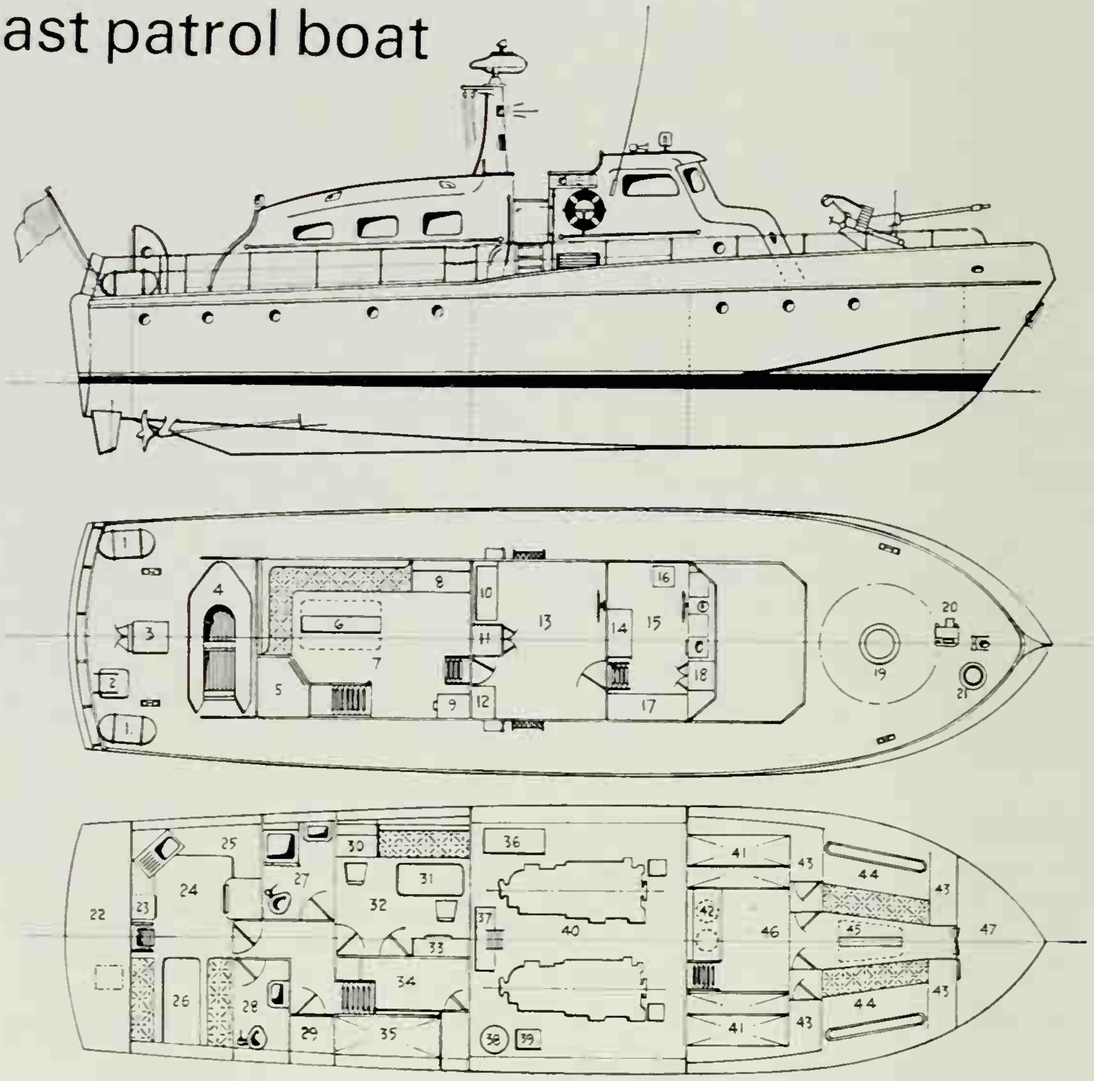
18.5m (60ft 10in) fast patrol boat

1 Liferaft
2 WT hatch
3 Companion to cabin
4 Inflatable boat
5 Sideboard
6 Drop-leaf table
7 Deck saloon and office
8 Writing desk
9 Filing cabinet
10 Locker seat
11 Engineroom companion
12 Flag locker
13 Open bridge
14 Chart table
15 Control house
16 Flush hatch
17 RT table
18 Hinged hatch
19 QF gun
20 Windlass
21 Emergency scuttle
22 Aft peak/steering gear and fuel tanks
23 Refrigerator
24 Galley
25 Dresser cupboards under
26 Table
27 Officers' toilet
28 Crew's toilet
29 Galley store
30 Writing desk
31 Table
32 Officers' mess
33 Sideboard
34 Officers' cabin
35 Upper and lower berths
36 Generator
37 Batteries
38 HW boiler
39 Water pressure set
40 Engine room
41 Two fixed berths and one cot berth
42 Wash basin cabinet
43 Cupboards
44 Folding cot berth
45 Hinged table
46 Crew's cabin
47 Fore peak and store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Patrol boats

Twin-screw boats

12.2m (40ft)

The twin-screw 12·2m (40ft) patrol boat is a development of a series of small patrol boats designed and built by Brooke Marine Limited.

The craft has been developed over a period of 20 years and is capable of high speed in bad sea conditions. There are three 0·30in (7·62mm) machine gun positions, giving 360 deg arc of fire.

Facilities are provided for the transportation of troops, and crew accommodation is more than ample for a craft of this size.

18.5m (60ft 10in)

This craft is a fast patrol boat with crew living accommodation and capable of carrying medium-sized armament in a hull of minimum dimensions.

Accommodation both above and below decks allows the use of this craft for customs and police duty in addition to naval patrol work.

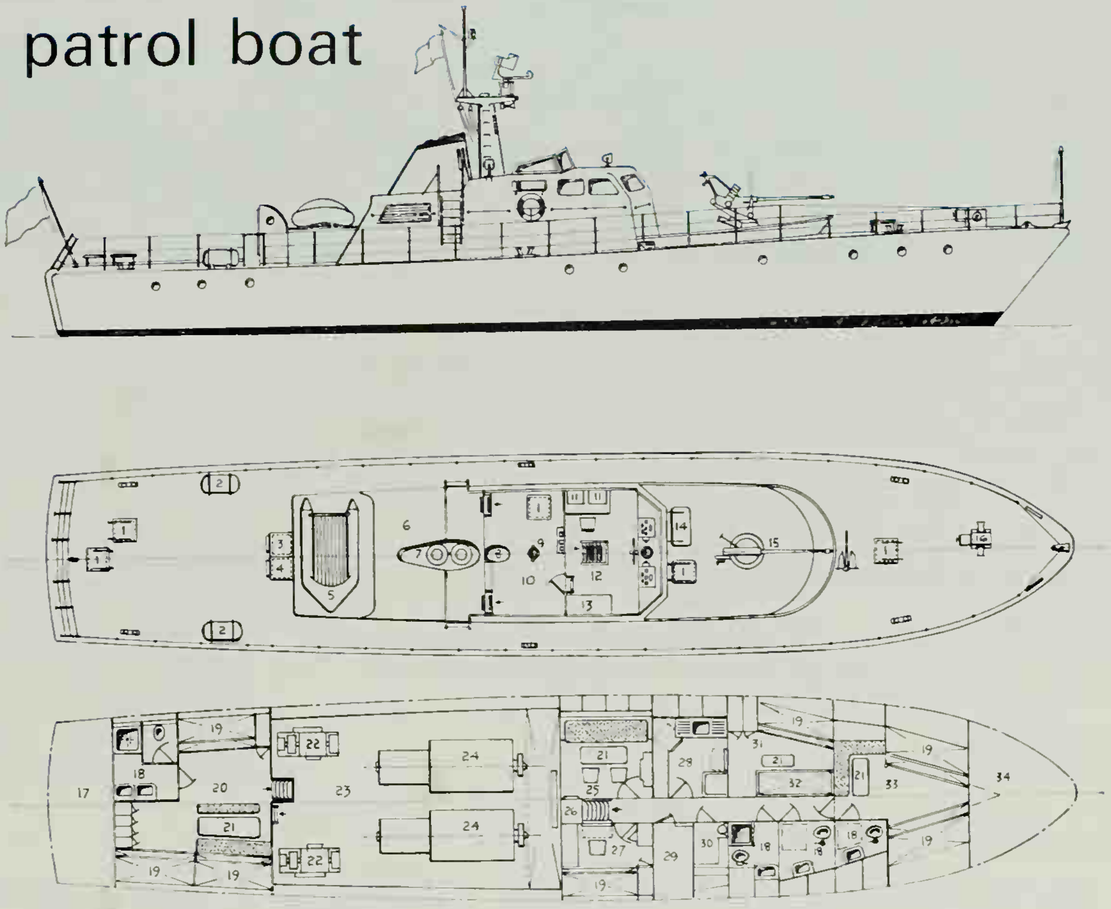
In addition to the 30mm naval gun, positions are available for a 0·30in (7·62mm) machine gun on the bridge.

26.8m (88ft)

This craft can undertake comprehensive patrol duties and is designed for ease of maintenance and economical operation.

The vessel may be armed with a variety of weapons to suit various roles.

26.8m (88ft) fast patrol boat



1	Hatch
2	Liferaft
3	Companion to cabin
4	ER entrance
5	'Z' boat
6	Semi-portable top for engine removal
7	Funnel
8	Mast
9	Compass
10	Bridge
11	RT equipment
12	Control house
13	Chart table
14	RV ammunition locker
15	QF gun
16	Windlass
17	Aft peak/steering gear/store
18	Toilet
19	Upper and lower berths
20	Crew's cabin
21	Table
22	Generator
23	Engine room
24	Main engine
25	Ward room
26	Refrigerator
27	Officers' cabin
28	Galley
29	Magazine
30	Galley store
31	PO's cabin
32	Single berth
33	Crew's cabin
34	Fore peak/cable locker/store

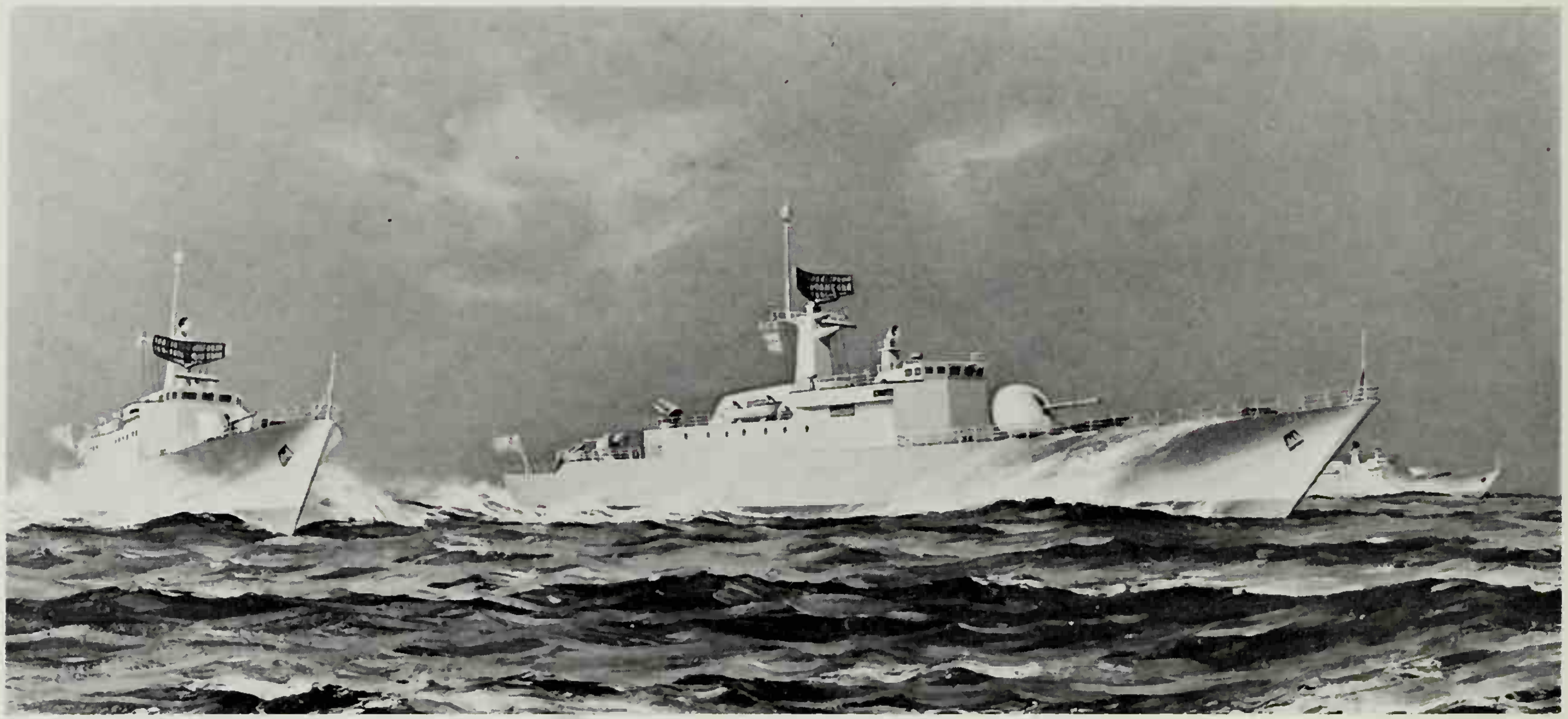
BROOKE MARINE LIMITED
Lowestoft, Suffolk, England
Telephone: Lowestoft 5221 Cables: Brookcraft Lowestoft Telex: 97145

1968

900-ton frigate—Vedette

The Vickers Vedette has been designed to fulfil tactical and strategic roles which fall in the gap between patrol boats/corvettes and the larger sophisticated frigates.

Within the Vedette series, the Type 521 represents one approach where the simplest effective armament is carried to support a general-purpose role. The Type 522, illustrated, incorporates within the same dimensions and displacement a much more sophisticated and powerful armament to allow consideration of the flexibility of such a weapon outfit, fully adaptable to a navy's particular requirement.



Vedette Type 522, with Type 521 shown on the left

Specification (Type 522)

Dimensions
Length, waterline: 76·2 m (250 ft 0 in)
Breadth: 9·5 m (31 ft 0 in)
Depth to No 1 deck: 7·2 m (23 ft 6 in)
Draught, deep condition: 2·9 m (9 ft 6 in)
Displacement, deep condition: 900 tons

Main machinery
Two sets, each consisting of one Maybach MD 1082 marine diesel engine driving a fixed-pitch propeller through a reversing/reduction gearbox
Total maximum power: 6600 shp

Performance
Maximum speed, deep condition: 22 knots
Range at 22 knots: 2800 km (1500 nm)
Range at 16 knots: 5500 km (3000 nm)

Armament (typical fit)
Medium-range gun: one 4·5-inch Mk 8 mounting
Close-range missiles: one 3-barrelled lightweight Seacat system
Close-range guns: one Twin—30 mm Hispano-Suiza mounting
Anti-submarine: one Terne medium-range weapon system
Computer-controlled or assisted fire-control system, air-warning and tracking radars

Accommodation
For up to about 95 officers and men

Customer support services

The facilities and experience within the Vickers Technical Aid organisation, developed on Leander Class frigates, submarines, and the Type 42, will be available in support of medium frigate and Vedette construction.

For overseas construction, the extent of aid given depends on customer requirements but typically includes advice on shipyard layout and equipment, provision of ship drawings and documentation, ordering equipment and monitoring sub-contractors, planning, assistance with setting-to-work, provision of technical and supervisory staff and training.

Besides overseas technical aid, Vickers can provide the following support services:

Weapons system consultancy
Weapons system tuning and test
Operational training co-ordination
Refit and in-service support.

Escort and patrol vessels

of 900 tons and 2100 tons displacement

Medium frigate

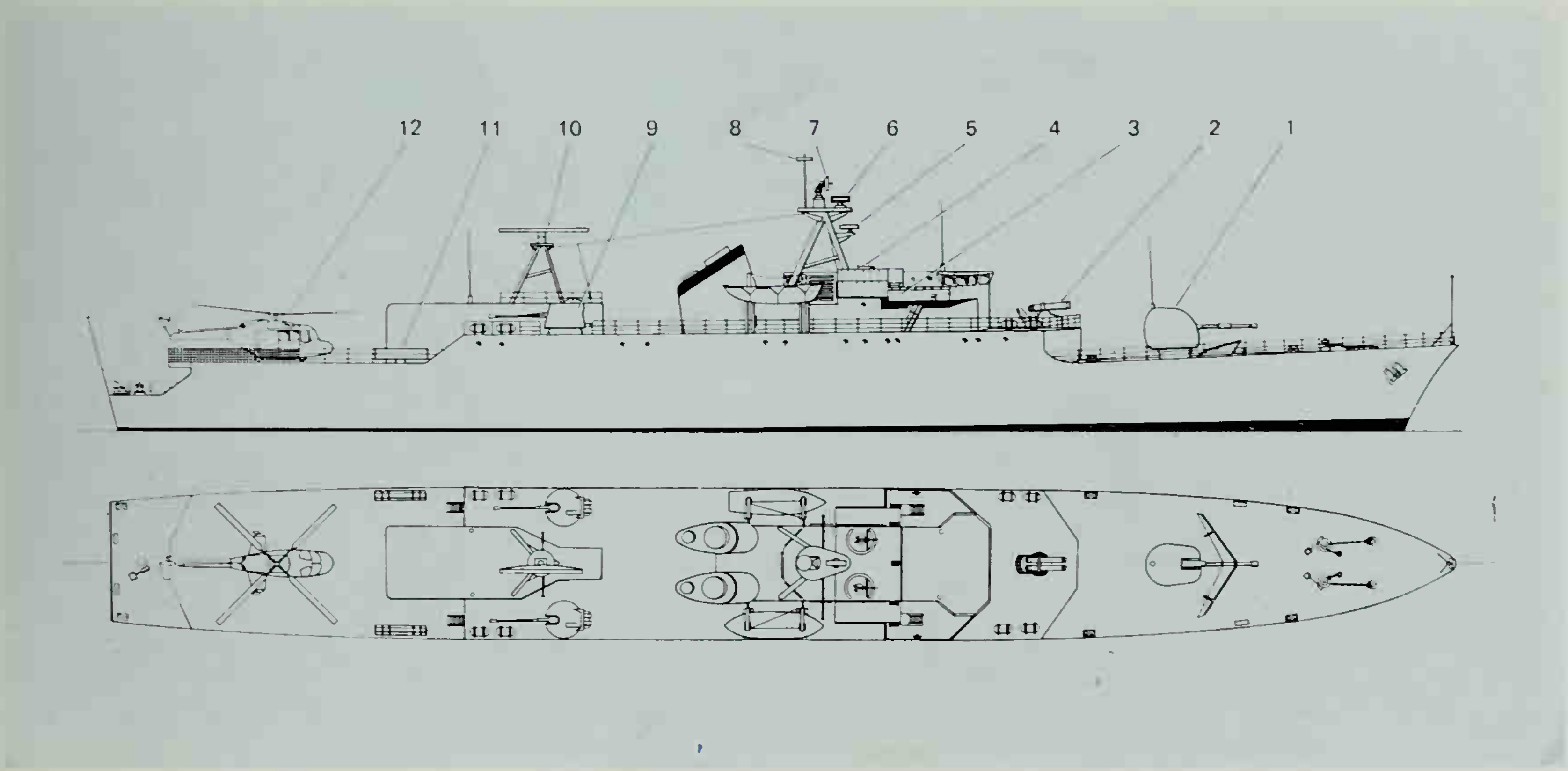
The Vickers medium frigate has been designed to provide navies contemplating new construction with an effective replacement for the Leander Class frigate. The design includes many of the important features and the high standards to be found in new ships of the Royal Navy.

The Type 2004, featured here, incorporates a machinery plant identical with that specified for future Royal Navy frigates and destroyers.

There are two main machinery sets, each consisting of one Olympus TM3B and one Tyne 209 marine gas turbine (both of which are described elsewhere in this Catalogue), coupled through a non-reversing gearbox to a controllable-pitch propeller.

The armament includes one 4·5-inch gun, two 76 mm guns and two 20 mm Oerlikon guns, rocket launchers and torpedo tubes.

Alternative machinery plants and weapons systems can be fitted to meet particular requirements.



1 Single 4·5 in Mk 8 gun
2 Twin Bofors 375 mm anti-submarine rocket launcher
3 2 in rocket flare launcher, port and starboard
4 Single 20 mm Oerlikon gun, port and starboard
5 978 navigation radar
6 944 IFF radar
7 RTN 10X fire control radar
8 RDL 2 aerial
9 Single 76/62 mm Oto Melara gun, port and starboard
10 992 Q radar
11 Triple Mk 32 torpedo tubes, port and starboard
12 WG 13 helicopter

Specification (Type 2004)

Dimensions
Length, waterline: 97·5 m (320 ft 0 in)
Breadth: 11·6 m (38 ft 0 in)
Depth to No 1 deck: 8·7 m (28 ft 6 in)
Draught, deep condition: 3·5 m (11 ft 6 in)
Displacement, deep condition: 2100 tons

Machinery
Two sets (one Olympus TM3B and one Tyne 209 marine gas turbine each) non-reversing gearbox, controllable-pitch propeller
Maximum power: 50 000 shp
Maximum cruise power: 7000 shp

Performance
Maximum speed: 34 knots
Range at 34 knots: 1840 km (1000 nm)
Range at 18 knots: 8300 km (4500 nm)

Armament
Gun armament:
One 4·5-inch Mk 8 gun mounting
Two 76/62 OTO Melara compact gun mountings
Two 20 mm Mk 7A Oerlikon guns

Anti-submarine armament:
One Bofors 375 twin anti-submarine rocket launcher
One MATCH system with WG 13 helicopter
Two Mk 32 triple anti-submarine torpedo tubes

Accommodation
For up to 170 officers and men

VICKERS SHIPBUILDING GROUP
Barrow Shipbuilding Works
PO Box 6, Barrow-in-Furness, Lancashire, England
Telephone: Barrow-in-Furness 20351 Cables: Vicarmsea Barrow-in-Furness
Telex: 6571

Vickers

Above and left: IIS *Saam* at full power during preliminary trials. *Saam* is the first of four fast destroyers for the Imperial Iranian Navy, two of which are being built by Vosper Thornycroft, and two by Vickers (Shipbuilders) Ltd. The design is a modification of the 40-knot Vosper Thornycroft Mk 5 frigate

Below: Vosper Thornycroft Mk 7 frigate after launching

Frigates

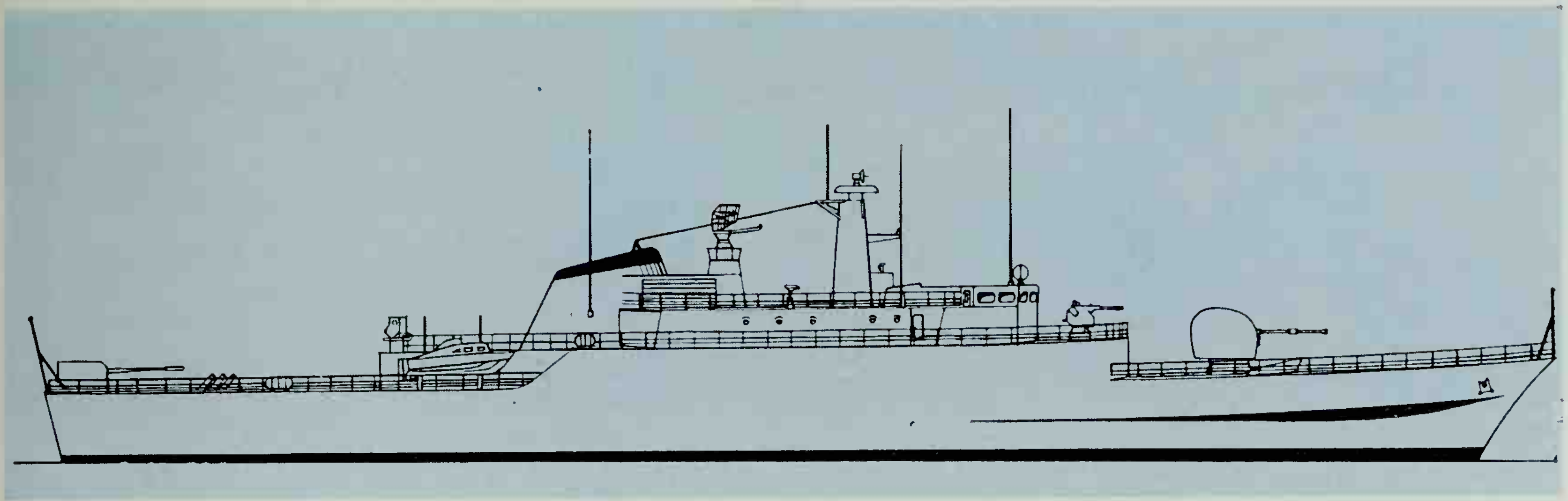
1200 tons to 1500 tons displacement

Modern frigates of perhaps 2800 tons with a complement of more than 250 officers and men are comparatively expensive ships both to build and to operate; so much so, indeed, that even the great naval powers are able to have them only in small numbers.

The Vosper Thornycroft Mk 5 (1200 tons) and Mk 7 (1450 tons) frigates have been designed with two main objectives: (1) to provide smaller and much less expensive ships, with complements not greatly exceeding 100, able to carry out most of the functions of the larger frigate and (2) to take every advantage of the latest developments of both weapons and machinery to produce the most effective possible fighting units. The use of Rolls-Royce Olympus gas turbines gives the Mk 5 frigate a maximum speed of 40 knots.

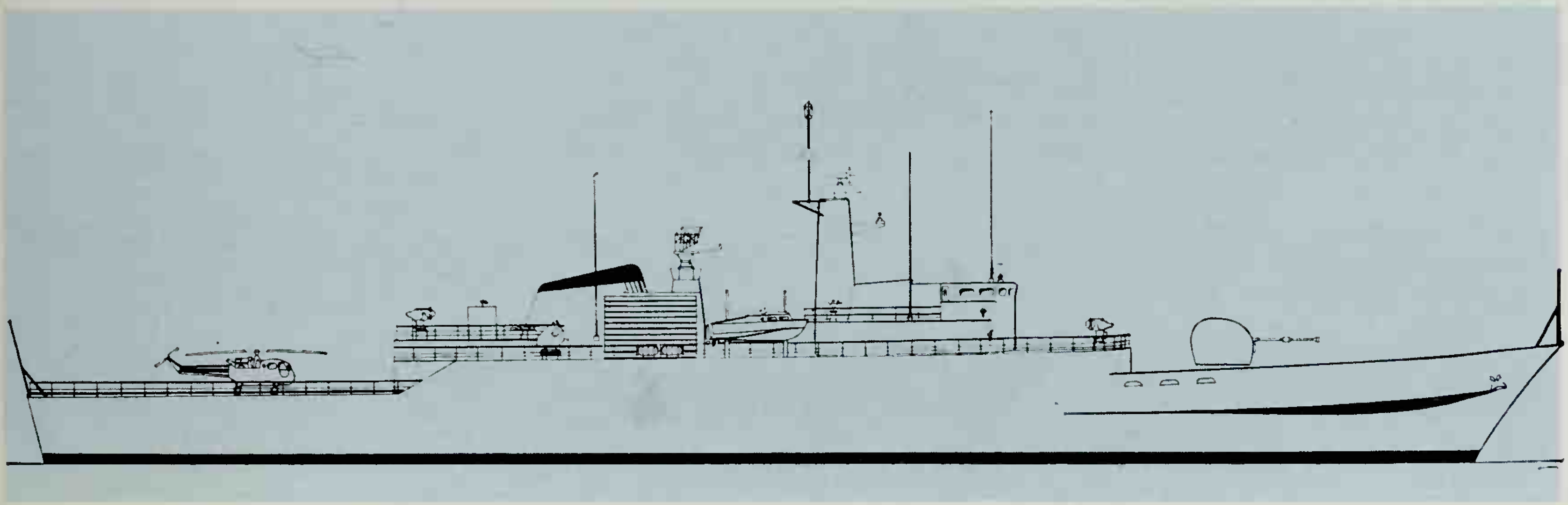
A wide choice of weapons is available for frigates of this type, embracing anti-ship and anti-aircraft guided missiles, guns of various calibres and anti-submarine mortars or torpedoes, all with their particular control equipment and action information facilities, up to a total weight of about 100 tons. In a Mk 7 frigate a helicopter complete with hangar can also be carried.

Four fast destroyers, based on the Vosper Thornycroft Mk 5 design, have been ordered for the Imperial Iranian Navy, the first of which is seen opposite during her preliminary trials. A Mk 7 frigate for the Libyan Navy is also under construction.



A Mk 5 frigate armed with one Vickers 4·5in (114·3mm) gun forward and a twin 35mm Oerlikon gun aft. Both are controlled by Contraves fire control equipment. Nord Aviation guided missiles and missile control are also fitted. Short-range sonar equipment and anti-submarine mortar are fitted as well as two hand operated 40mm guns and two rocket flare launchers for target illumination at night

Length overall 94·5m (310ft)
Length between perpendiculars 88·4m (290ft)
Beam on LWL (max.) 10·4m (34ft)
Depth moulded 7·6m (25ft)
Draft moulded 3·2m (10ft 6in)

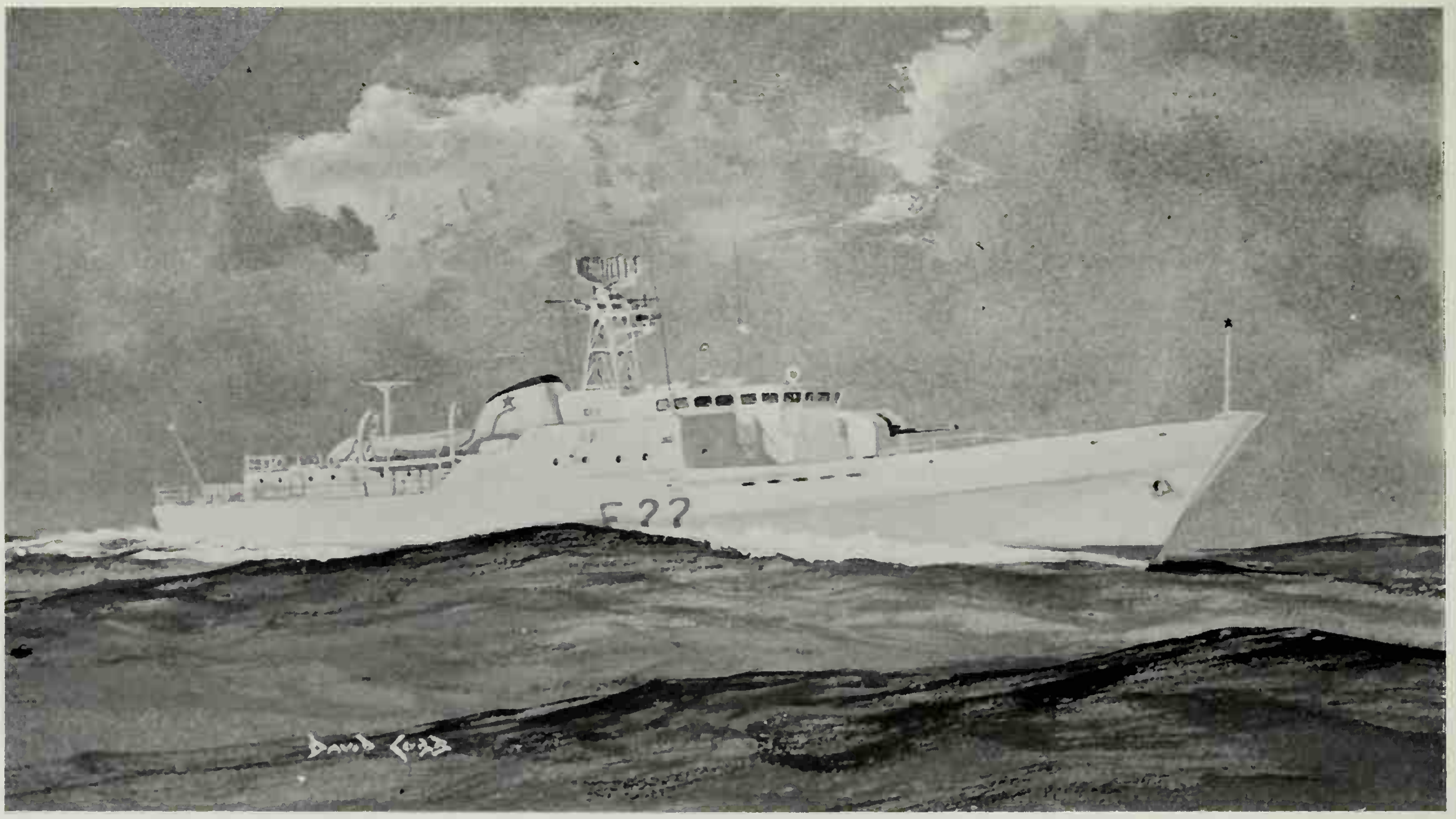


A Mk 7 frigate armed with one Vickers 4·5in (114·3mm) gun, two triple Seacat launchers, two 40mm guns and two rocket flare launchers. Fire control is by Contraves. A helicopter, which can be armed with anti-submarine torpedoes or Nord Aviation guided missiles, is carried in its own hangar. Long-range sonar is also fitted. It would be possible in this design also to carry a twin 35mm Oerlikon gun if required

Length overall 101·6m (333ft)
Length between perpendiculars 94·5m (310ft)
Beam on LWL (max.) 11·0m (36ft)
Depth moulded 7·9m (26ft)
Draft moulded 3·4m (11ft)

VOSPER THORNYCROFT
Shipbuilding Division
Vosper House, Paulsgrove, Portsmouth, England
Telephone: Cosham 79481 Telex: 86115

1966
1969



A Vosper Thornycroft Mk 3 corvette 61m (200ft) in length, speed 28 knots

GNS *Kromantse*, one of two Mk 1 corvettes supplied to the Ghana Navy in 1964. They are 53·9 m (177 ft) in length, speed 20 knots

LNS *Tobruk*, a Mk 1 corvette supplied to the Libyan Navy in 1966. Length 53·9 m (177 ft), speed 18 knots

Corvettes

440 tons to 800 tons displacement

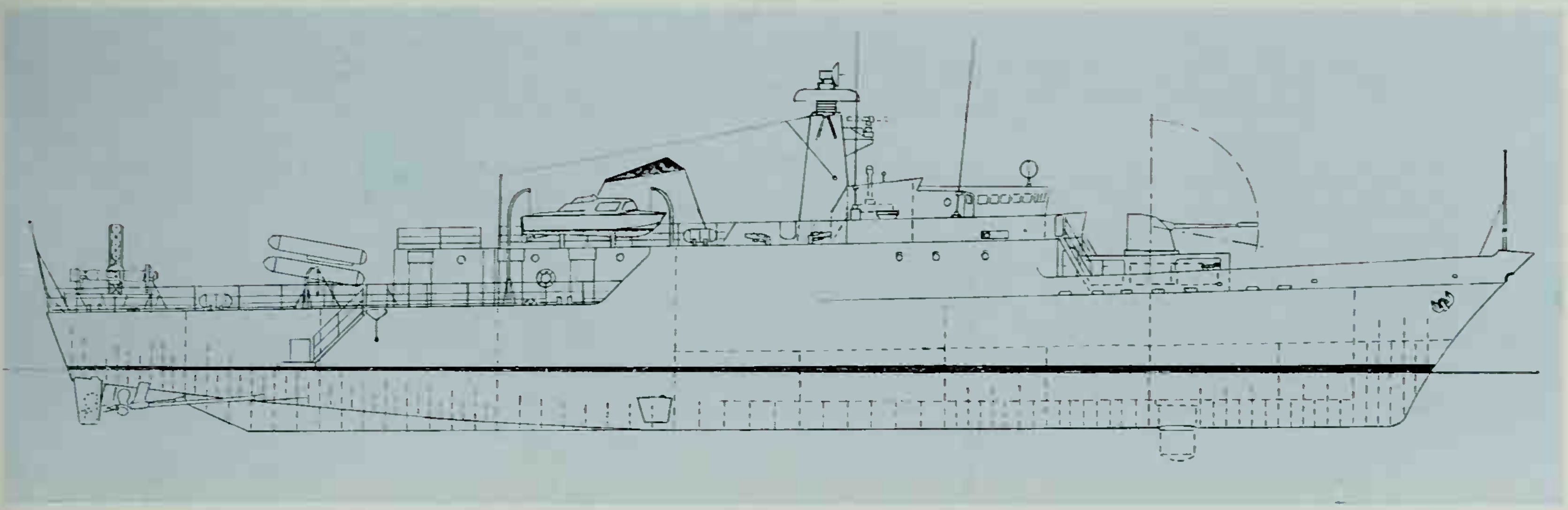
The term 'corvette' includes not only small unsophisticated vessels with comparatively simple armament but also larger and faster vessels with very advanced weapons and equipment. Corvettes are the smallest ships with a realistic anti-submarine capability. Because of their small size and basic simplicity they are considerably less expensive than frigates in prime cost and have crews of only about 50 to 60 officers and men.

The Vosper Thornycroft corvette range consists of the Mk 1 type of 440 tons displacement, the Mk 3 of some 600 tons and the Mk 8 of some 800 tons.

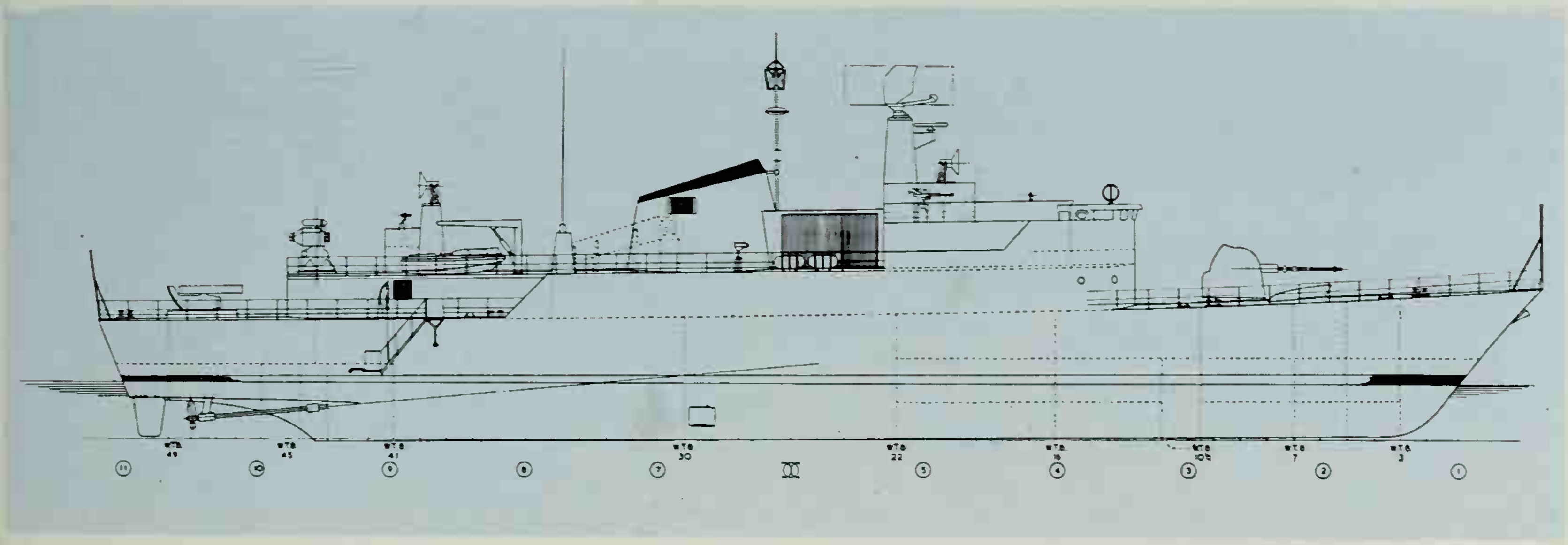
Mk 1 corvettes are diesel-driven ships with a maximum speed of 18–20 knots. The Mk 3 is a larger diesel-driven ship capable, with three engines, of speeds up to 26 knots. The Mk 8 CODOG corvette, 73·6 m (241 ft) in length, is powered by a single Olympus gas turbine driving twin screws, giving a maximum speed of 32 knots. Its cruising speed, on two 16-cylinder diesels, is 19½ knots. The Mk 9 corvette is similar to the Mk 8 but a little smaller and powered by two diesel engines. Its maximum speed is 29½ knots.

The ships can be armed with long-range and short-range anti-ship guided missiles, a variety of different lightweight guns or anti-aircraft missiles, anti-submarine mortar, depth charges or torpedoes, together with the appropriate radar, sonar and control equipment.

Two Mk 3 corvettes are under construction for the Nigerian Navy.



A typical Vosper Thornycroft Mk 3 corvette of advanced design, powered by three diesel engines. It has a maximum speed of over 26 knots and a cruising range of some 5500 km (3000 nm at 15 knots. The armament consists of a combination of long-range and short-range anti-surface guided missiles, as well as a 35 mm twin gun and anti-submarine armament. Modern fire control equipment, together with search and tracking radar, is also fitted.



A typical Vosper Thornycroft Mk 8 CODOG corvette. The forward gun is a 76 mm Oto Melara. A triple Seacat launcher is mounted aft. Both are controlled by a Ferranti-Selenia fire control system which includes an element of action information. A Bofors anti-submarine rocket launcher controlled by Plessey sonar is fitted to the aft deck. In other Mk 8 or Mk 9 designs the weapons outfit includes Exocet (or other) anti-ship guided missiles and anti-submarine torpedoes instead of the mortar.

VOSPER THORNYCROFT
Shipbuilding Division
Vosper House, Paulsgrove, Portsmouth, England
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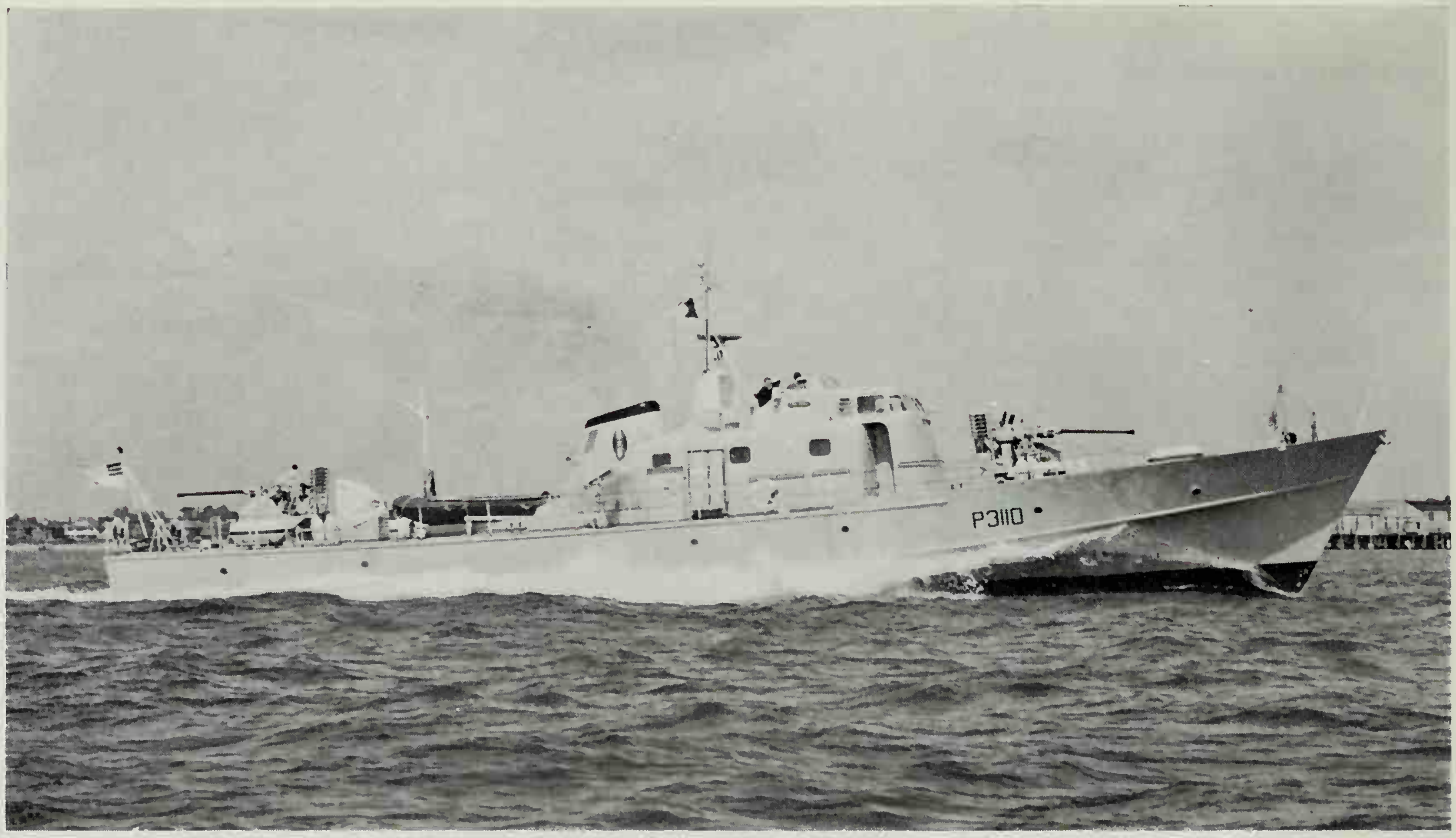
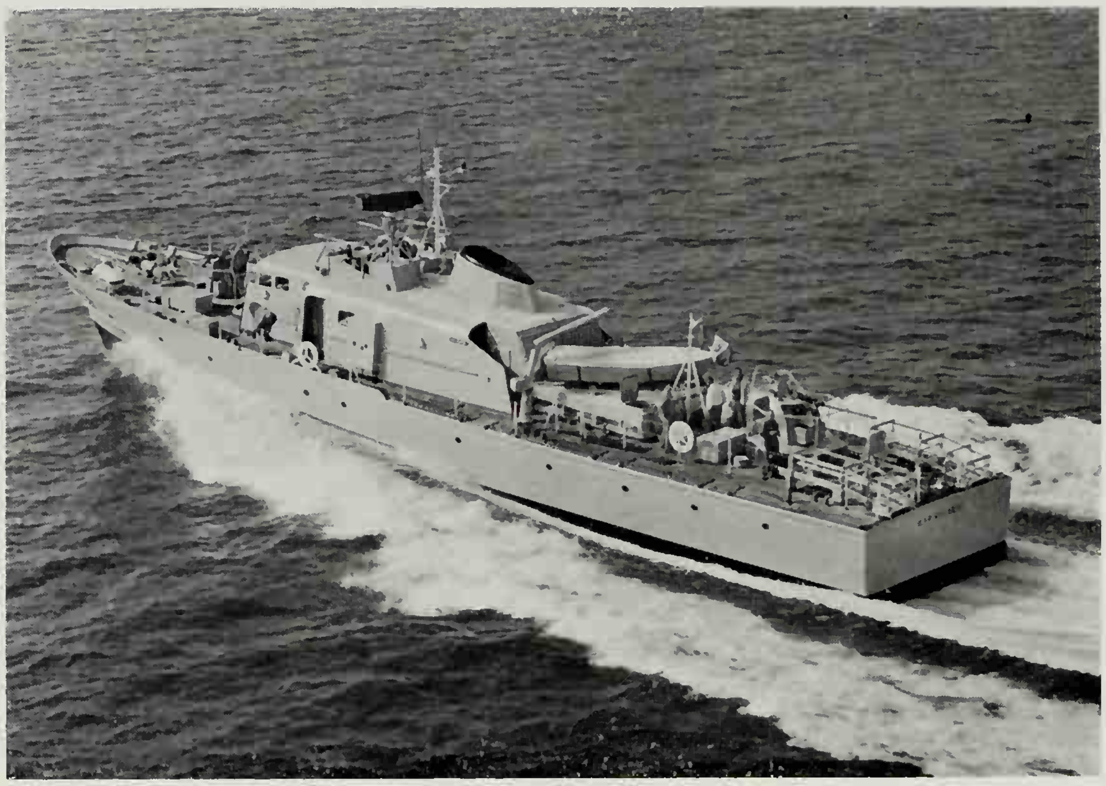
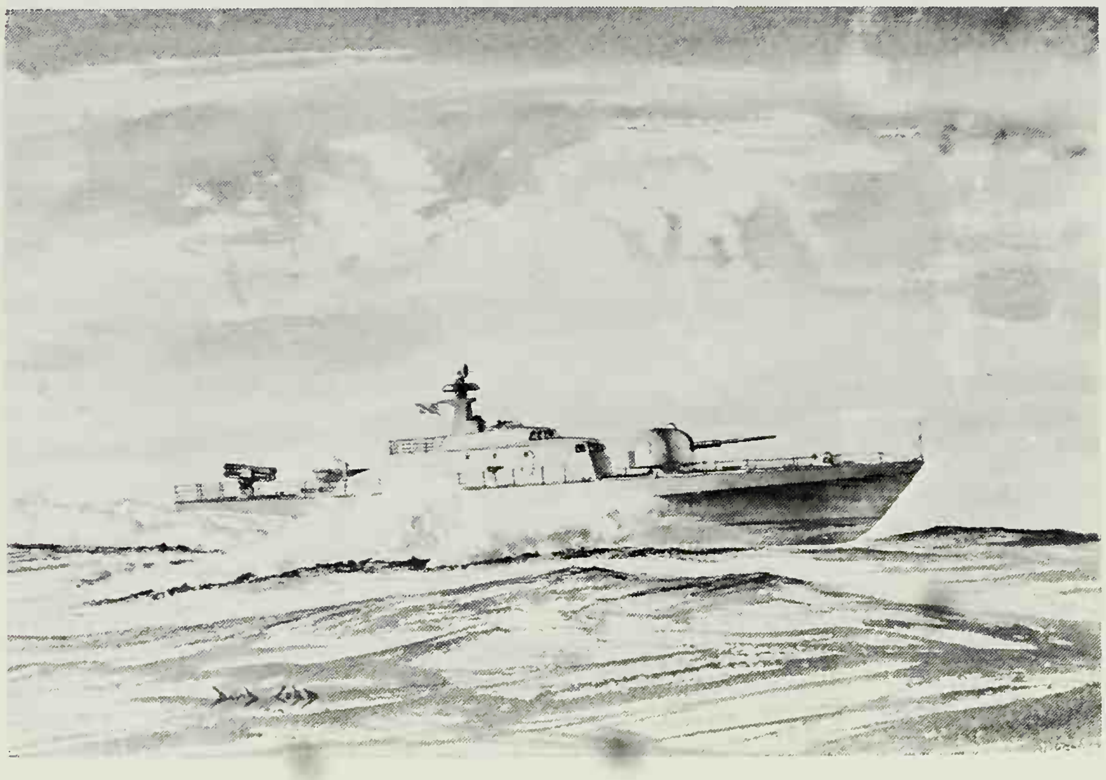
1966
1969



103ft (31·4m) patrol craft armed with two 40mm guns



110ft (35·5m) fast patrol craft, armed with two 20mm guns. An 80mm rocket launcher, torpedoes and depth charges can also be carried



142ft (43·3m) fast patrol craft armed with a 75mm gun and guided missiles. Boats of this type can be powered by diesels or gas turbines according to the performance required

Patrol craft

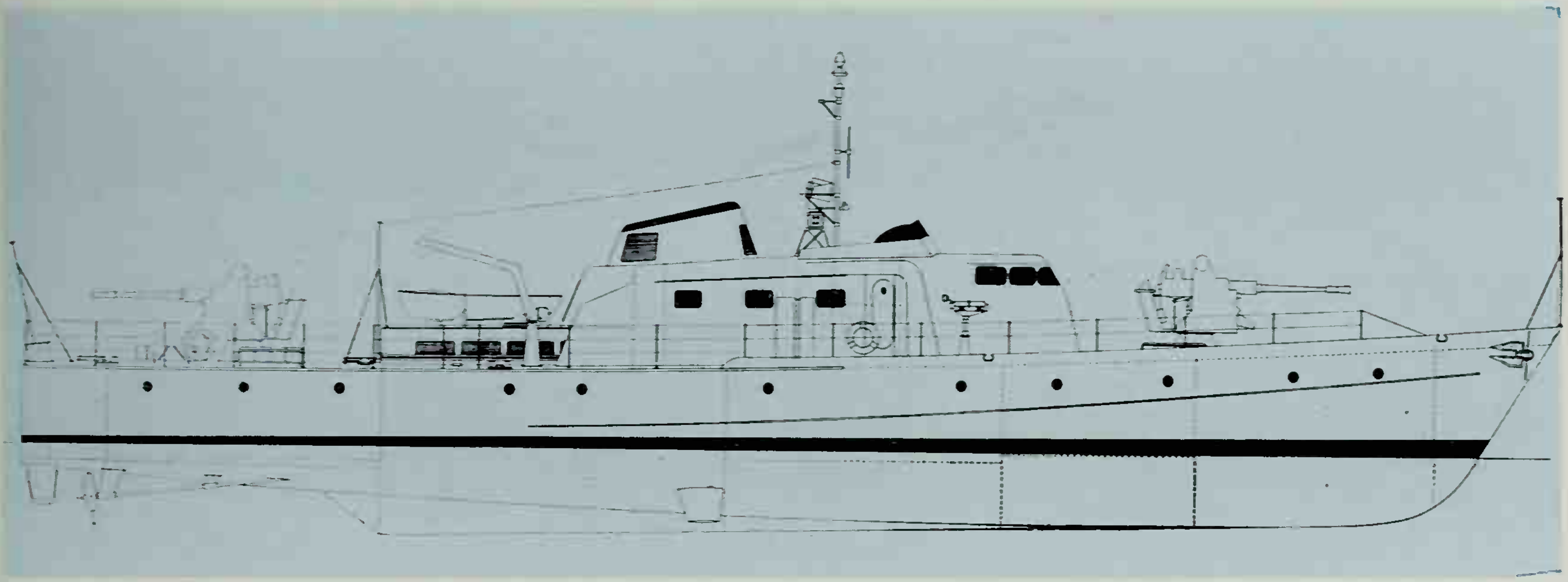
diesel-powered

Twenty-nine 103ft (31·4m) fast patrol craft have been supplied to the Royal Malaysian Navy, the Trinidad and Tobago Coast Guard and the Kenya Navy. They are built of steel, with two 40mm guns and a speed of about 25 knots.

Six 110ft (33·5m) fast patrol craft were supplied to the Peruvian Navy in 1965. These are 30-knot vessels built of steel, armed with guns, rocket-propelled missiles, torpedoes and anti-submarine equipment.

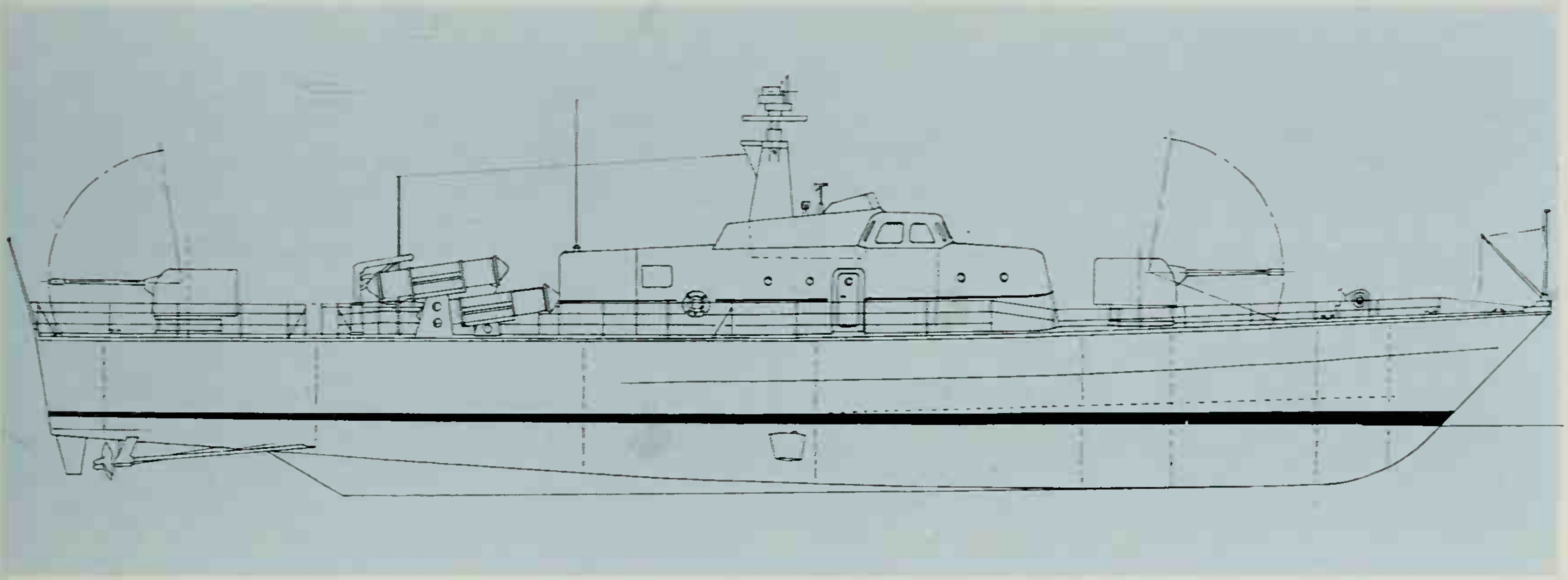
A further six 110ft (33·5m) fast patrol craft are at present (1968) being built for the Republic of Singapore. Two of the vessels are being built in Portsmouth, the remainder by Vosper Thornycroft Uniteers Ltd in Singapore.

A new design of 142ft (43·3m) fast patrol boat, armed with modern guns and guided missiles, has recently been built as a private venture. Many other smaller patrol craft have also been designed and built.



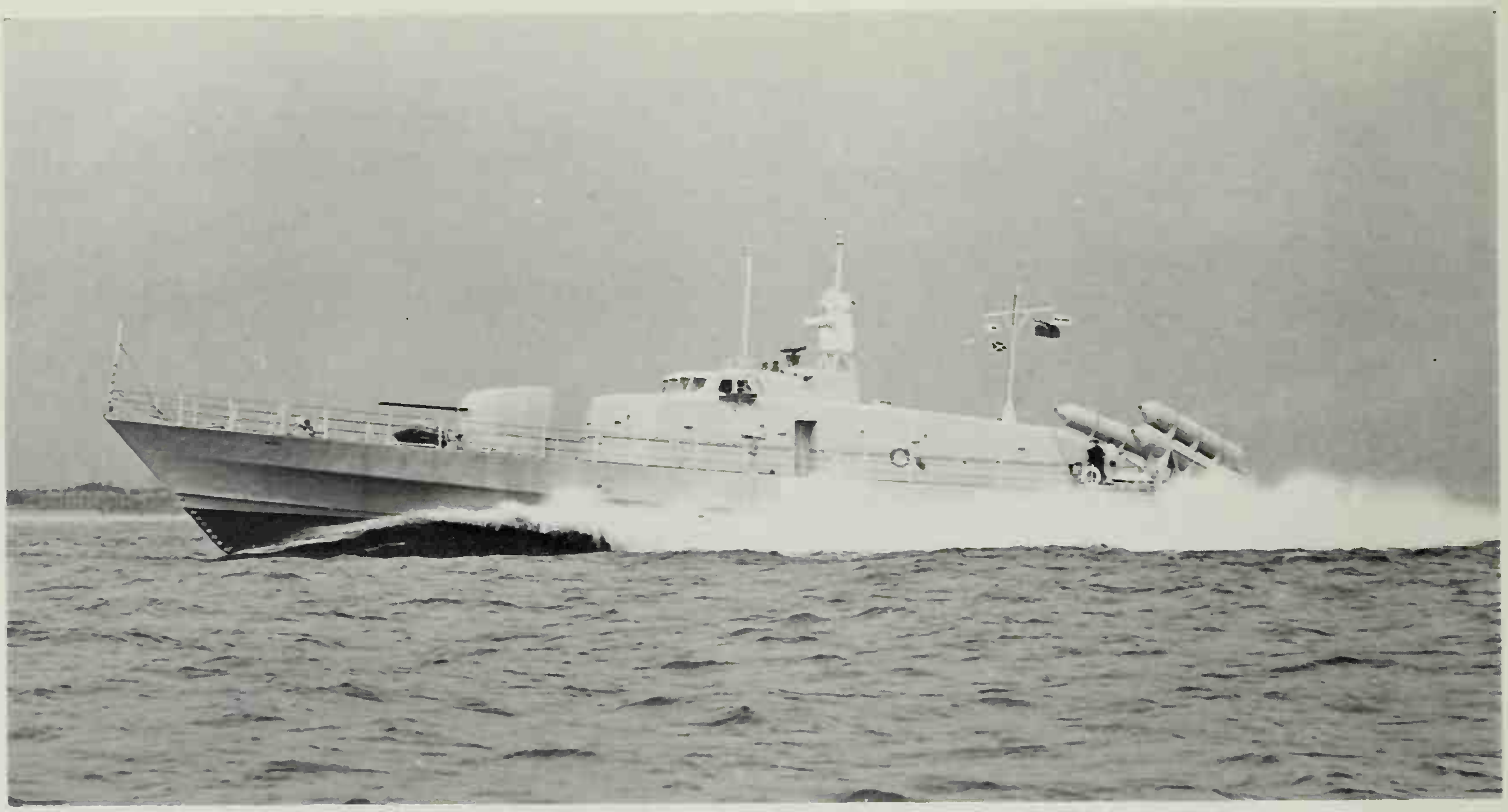
Typical Vosper Thornycroft 110ft (33·5m) 30-knot fast patrol boat armed with 40mm guns and powered by two diesel engines

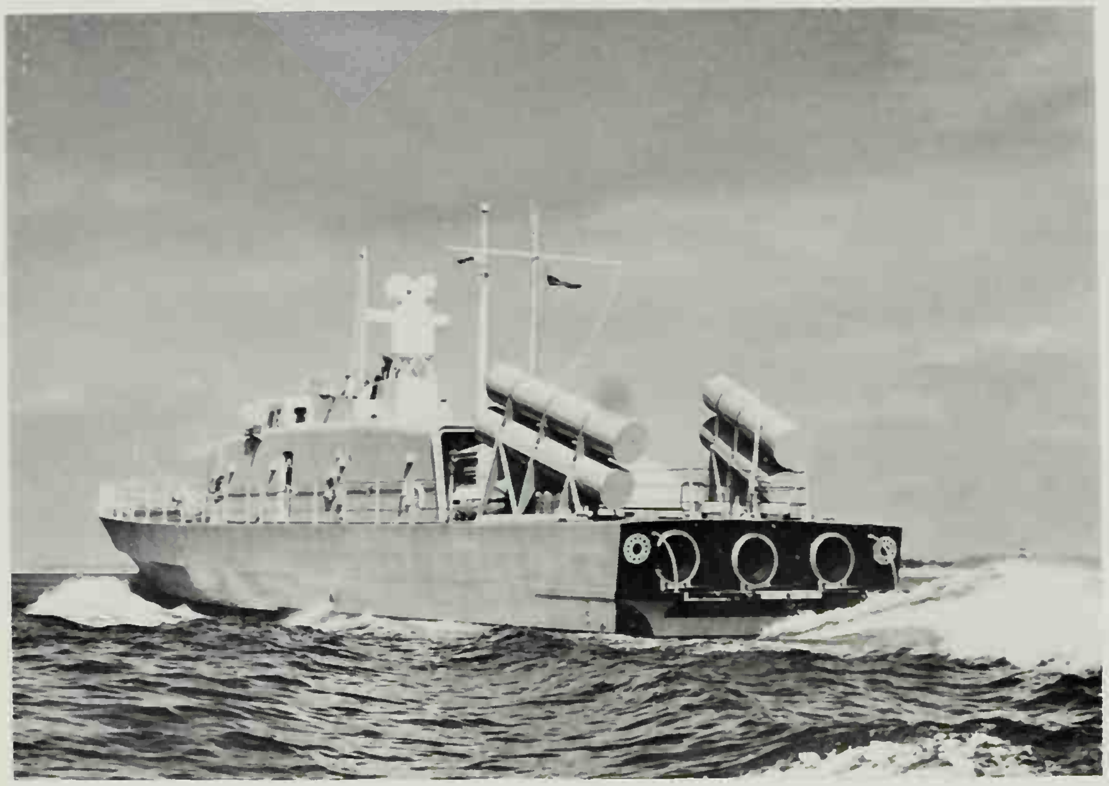
142ft (43·3m) fast patrol boat design. Four diesel engines or two gas turbines may be fitted according to performance required. The boat is armed with two twin 35mm guns and long-range anti-surface guided missiles



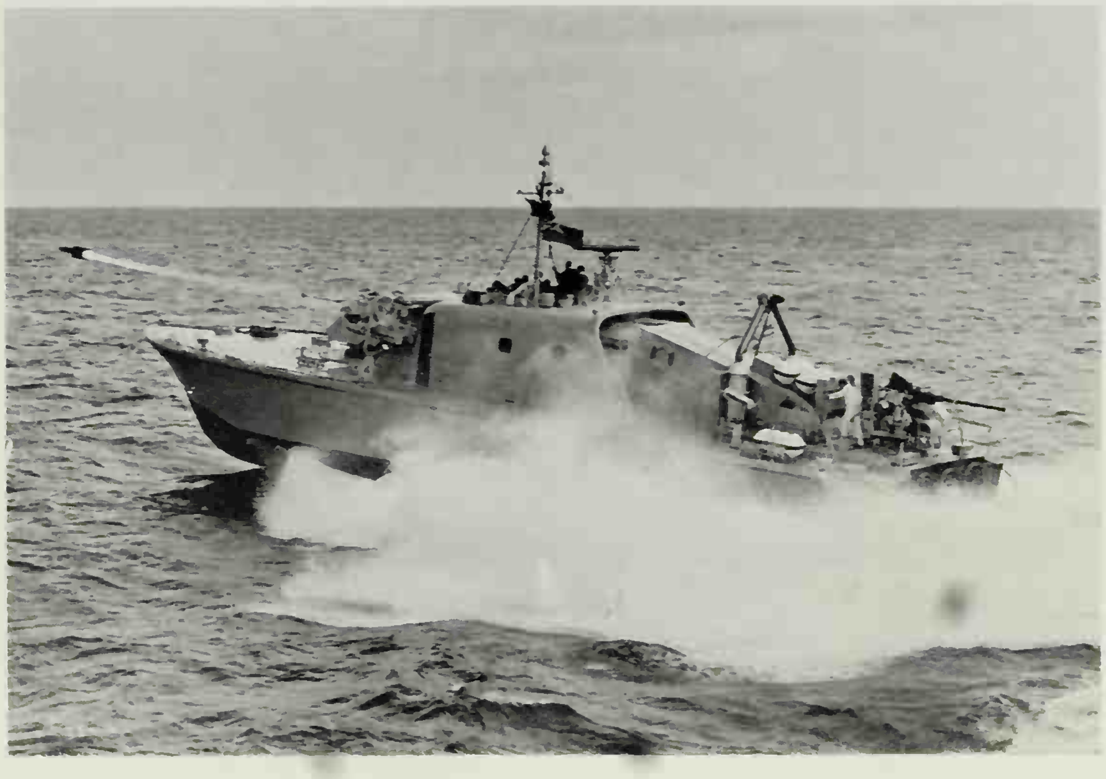
VOSPER THORNYCROFT
Shipbuilding Division
Vosper House, Paulsgrove, Portsmouth, England
Telephone: Cosham 79481   Telex: 86115

1966
1969





Top and left: Vosper Thornycroft private venture fast patrol boat *Tenacity*. This 43·3 m (142 ft) 40 knot gas turbine/diesel fast patrol boat, armed with an advanced weapons system of powerful modern guns and guided missiles, represents a new generation of fast patrol boats capable of engaging major warships and modern aircraft



LNS *Susa*, Libyan Navy, discharges a guided missile

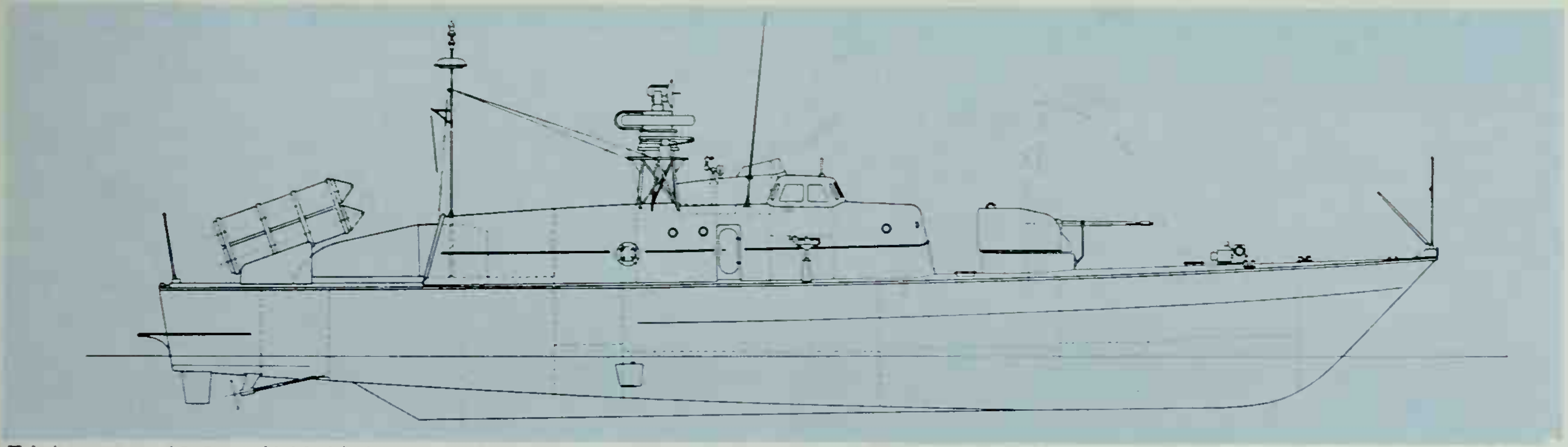
Patrol craft

gas turbine-powered

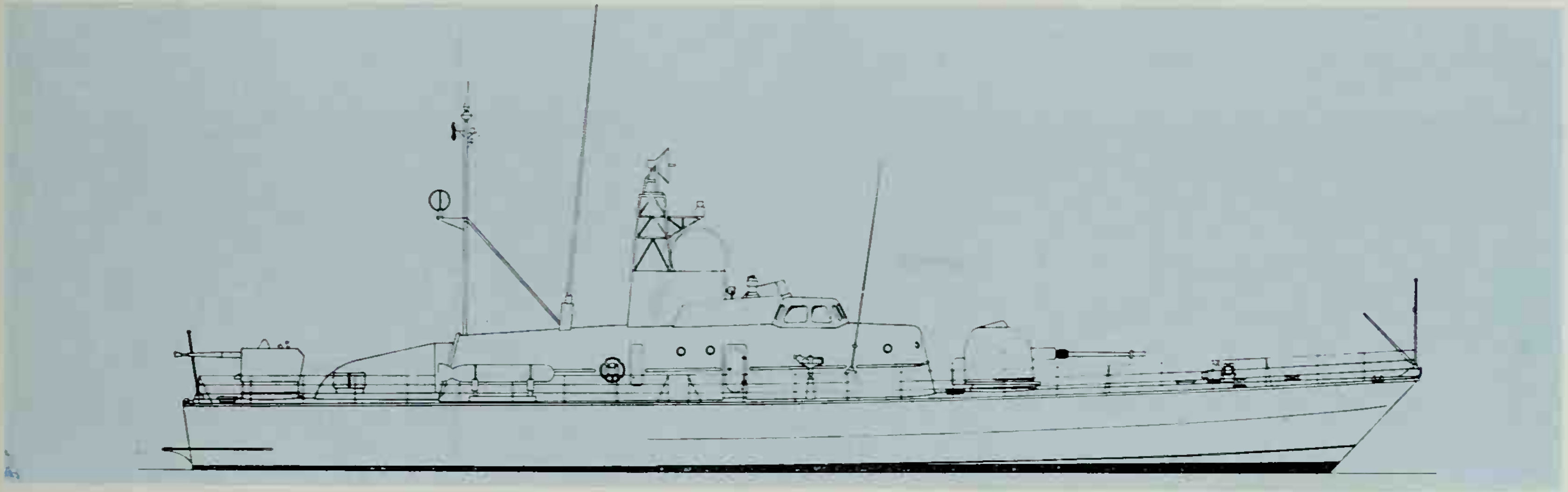
Following the 29·3 m (96 ft) fast patrol boats, twenty-one of which were designed and built for six of the world's navies during the last decade, a new generation of gas turbine fast patrol boats has been built as a prototype. Because of the high costs of building and manning large ships, the fast patrol boat of the future will increasingly be used for long patrols and as a major surface strike vessel.

Thus the latest Vosper Thornycroft fast patrol boat is much larger than previous patrol boats, capable of remaining at sea for a week or more and armed with anti-ship guided missiles and powerful modern guns capable of shooting down aircraft or guided missiles. A choice of individual weapons and fire-control equipment is available.

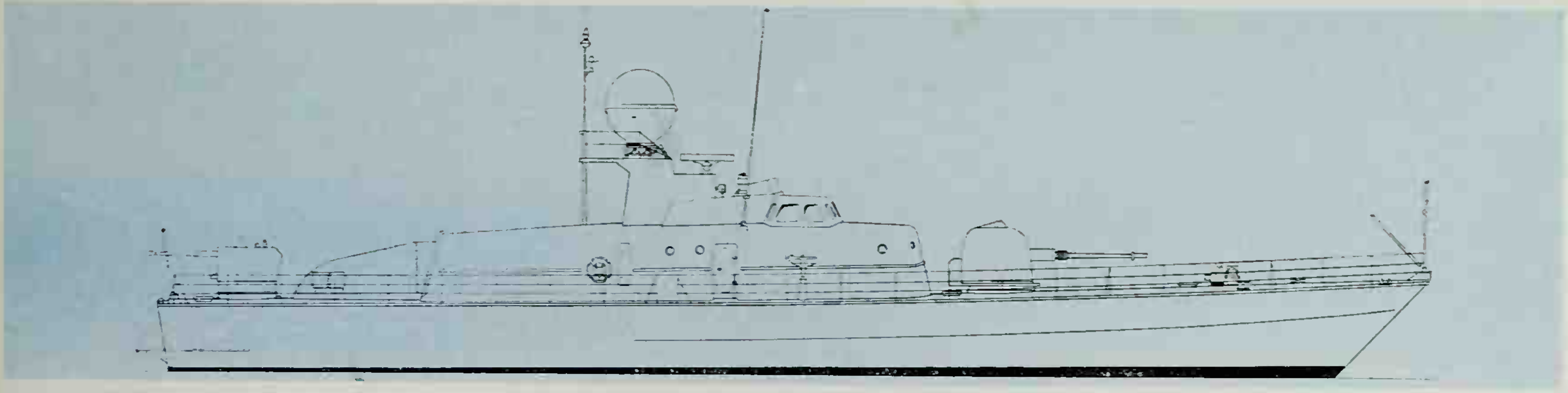
Nevertheless, the much less costly 29·3 m (96 ft) boat, with its exceptionally high speed of 55–60 knots and an armament of 40 mm guns, lightweight guided missiles and/or torpedoes, is still an extremely effective vessel in many applications.



Triple-screw 43·3 m (142 ft) fast patrol boat. The forward gun is an Oerlikon twin 35 mm controlled by Contraves Sea Hunter Mk 4, which also controls the four Contraves Sea Killer missiles in two fixed mountings on the aft deck



43·3 m (142 ft) fast patrol boat armed with one Oto Melara 76 mm gun and one Bofors 40 mm gun, controlled by Ferranti fire control with a separate optical sight for target indication or emergency use. Two torpedoes can also be carried if required



43·3 m (142 ft) fast patrol boat armed with one Oto Melara 76 mm gun and one Bofors 40 mm gun, controlled by NV Hollandse Signaal Apparaten fire control, with a separate optical sight for target indication or emergency use. Two torpedoes can also be carried if required

VOSPER THORNYCROFT
Shipbuilding Division
Vosper House, Paulsgrove, Portsmouth, England
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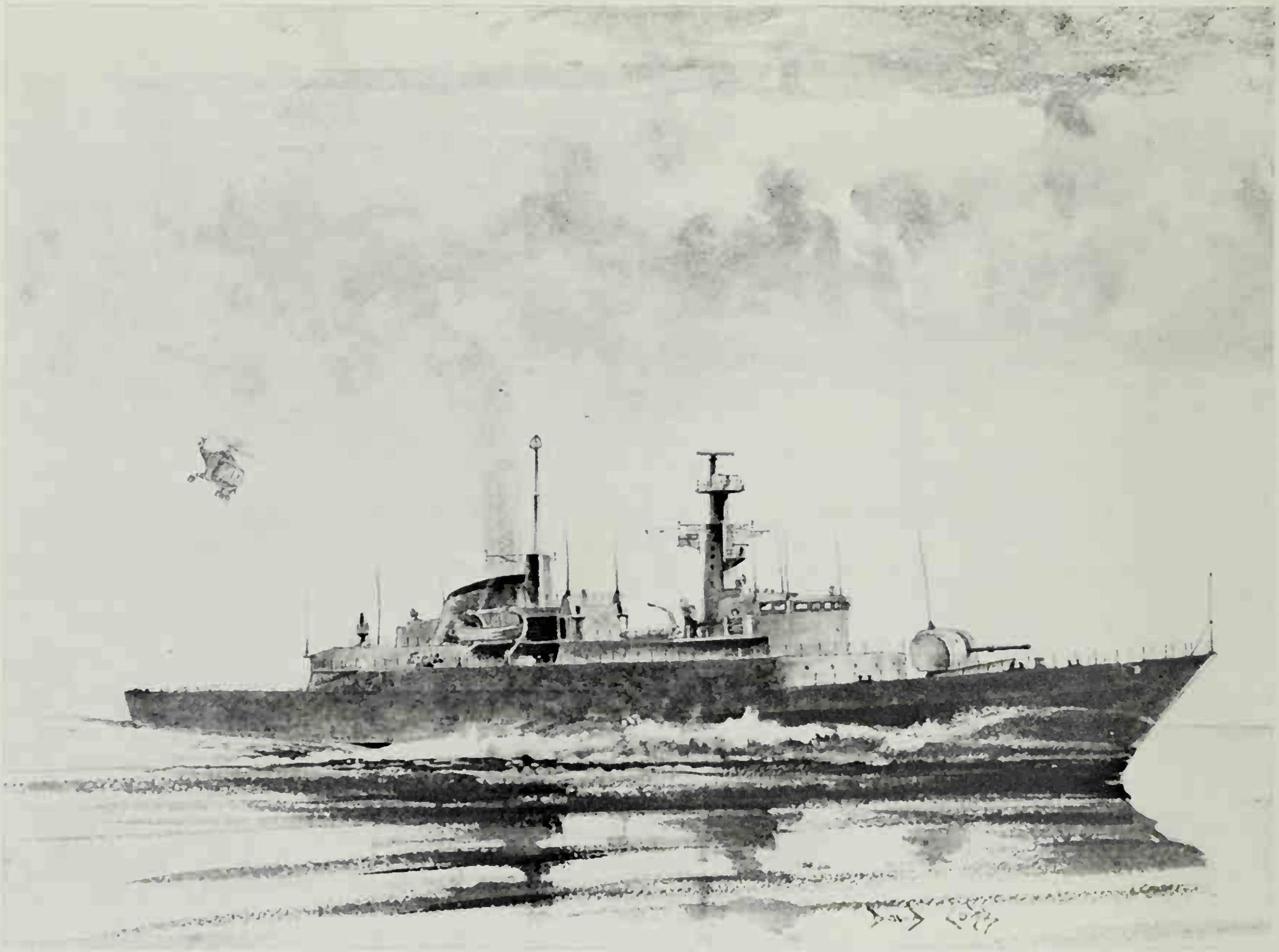
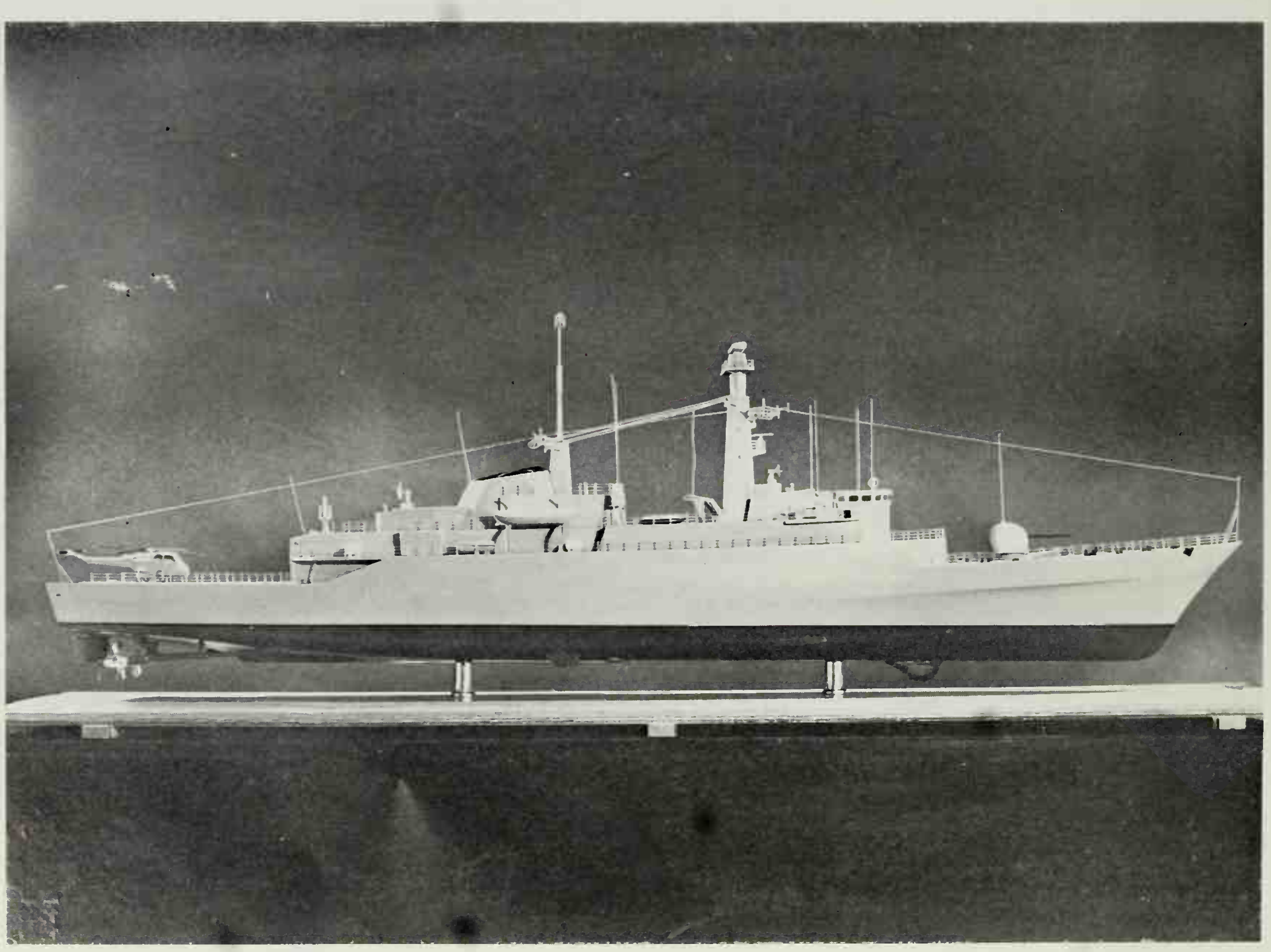
1966
1969



Artist's impression (above) and model (below) of Type 21 Frigate



Frigates

of 2500 tons displacement

In February 1968 the British Ministry of Defence (Navy) placed a contract with the Vosper Thornycroft Group of Portsmouth for the design of a frigate, to be prepared in the fullest collaboration with Yarrow (Shipbuilders) Ltd of Scotstoun. HMS *Amazon*, the first ship of the class, was ordered in March 1969 and two further ships in May 1970. All are being built by Vosper Thornycroft at Woolston.

The staff requirements called for a ship of about 2500 tons displacement which could contribute effectively to the defence of a convoy or other force, against surface ship or submarine attack and would moreover be fully capable of self-defence against aircraft, missiles or fast patrol craft. It had to be capable of matching comparable contemporary foreign ships in battle and performance. It also had to be able to patrol the high seas in all areas and in all weather and was required to be able to land armed or unarmed landing parties to deal with civil disturbance or natural disaster. Brief details of the design arrived at to meet all these requirements are given below.

Specification

Weapon systems
The design incorporates the most modern weapon systems controlled by miniaturised digital computers designed and built by Ferranti (England)
An integrated action information data-handling unit provides for the automatic tracking of targets and for their interrogation, and ensures the most effective use of the armament

Machinery and performance
In accordance with the latest British naval policy the ship is fitted with gas turbine main machinery and will have Olympus and Tyne gas turbines in a COGOG arrangement driving two shafts with controllable-pitch propellers. The maximum speed is about 34 knots and the cruising range more than 8300 km (4500 nautical miles) at 18 knots

Seakeeping
The hull has been developed to give the optimum combination of good seakeeping and high speed. The knuckle forward is designed to reduce wetness on the foredeck without causing heavy deceleration when the bow pitches into heavy seas

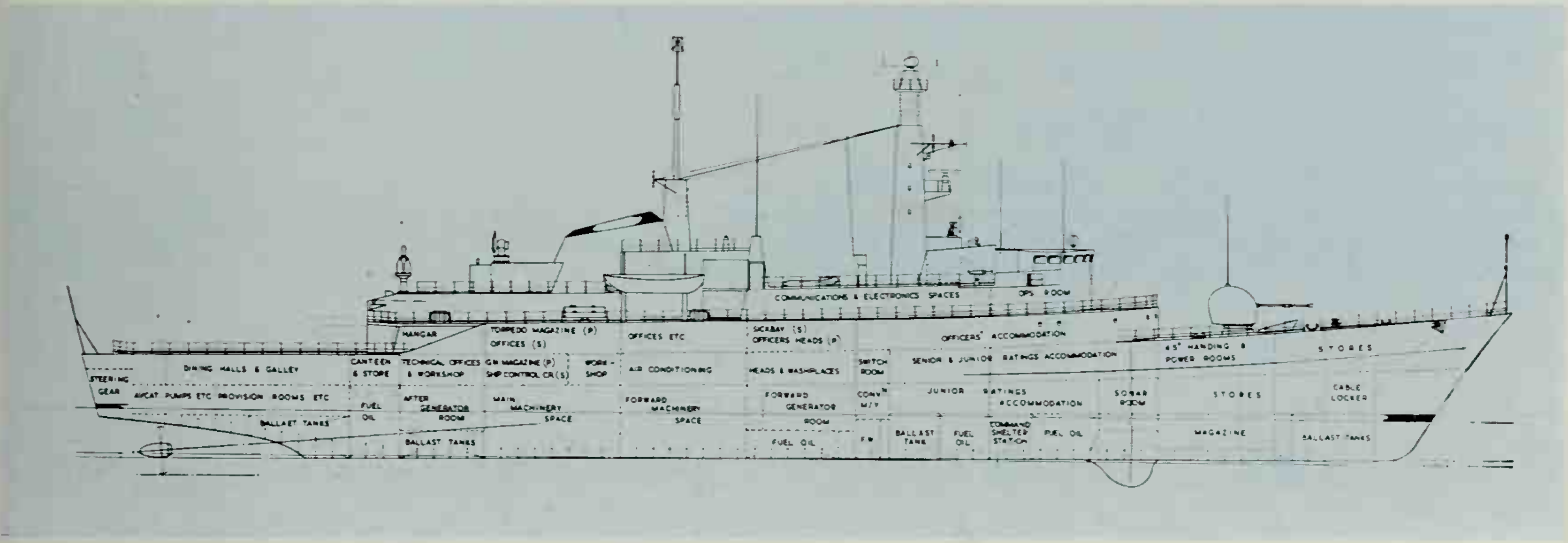
Navigation
The bridge is enclosed, with open wings at the same level, and is so designed that the maximum all-round view is provided from a central pelorus containing a gyro compass repeater. Engine telegraphs and steering control are sited on the bridge. Automatic steering is provided

Communications
Full ship-to-shore, ship-to-ship, ship-to-air radio communications to the latest British naval standards are provided

Accommodation
The total number of the ship's company will not exceed 170 but to allow some margin for training or other purposes, accommodation is provided for a total of 192 as follows:

1	commanding officer
14	officers (10 single and 2 double cabins)
19	chief petty officers
30	petty officers
128	junior ratings

The accommodation is air-conditioned and winterised throughout


HANGAR
TORPEDO MAGAZINE (P)
OFFICES (S)
OFFICES ETC
SICKBAY (S)
OFFICERS HEADS (P)
COMMUNICATIONS & ELECTRONICS SPACES
OPS ROOM
OFFICERS' ACCOMMODATION
STEERING GEAR
DINING HALLS & GALLEY
CANTEEN & STORE
TECHNICAL OFFICES & WORKSHOP
GW MAGAZINE (P)
SHIP CONTROL CR (S)
WORK-SHOP
AIR CONDITIONING
HEADS & WASHPLACES
SWITCH ROOM
SENIOR & JUNIOR RATINGS ACCOMMODATION
4.5" HANDING & POWER ROOMS
STORES
AVCAT PUMPS ETC PROVISION ROOMS ETC
FUEL OIL
AFTER GENERATOR ROOM
MAIN MACHINERY SPACE
FORWARD MACHINERY SPACE
FORWARD GENERATOR ROOM
CONV M/V
JUNIOR RATINGS ACCOMMODATION
SONAR ROOM
STORES
CABLE LOCKER
BALLAST TANKS
BALLAST TANKS
FUEL OIL
FW
BALLAST TANK
FUEL OIL
COMMAND SHELTER STATION
FUEL OIL
MAGAZINE
BALLAST TANKS

The British Ministry of Defence (Navy) has accorded the sole right to make overseas sales of ships of this design to Vosper Thornycroft and Yarrow (Shipbuilders) Ltd.

The design has been specifically tailored to the requirements of the Royal Navy. Clearly the sound basic concept and the detailed requirements of the Royal Navy will produce a fine warship, but it is fully recognised that other navies may require modifications in detail of both the armament and the equipment. Within the general space and weight concepts of the ship, there is ample scope to adapt the design to meet the particular requirements of other navies.

1966
1969

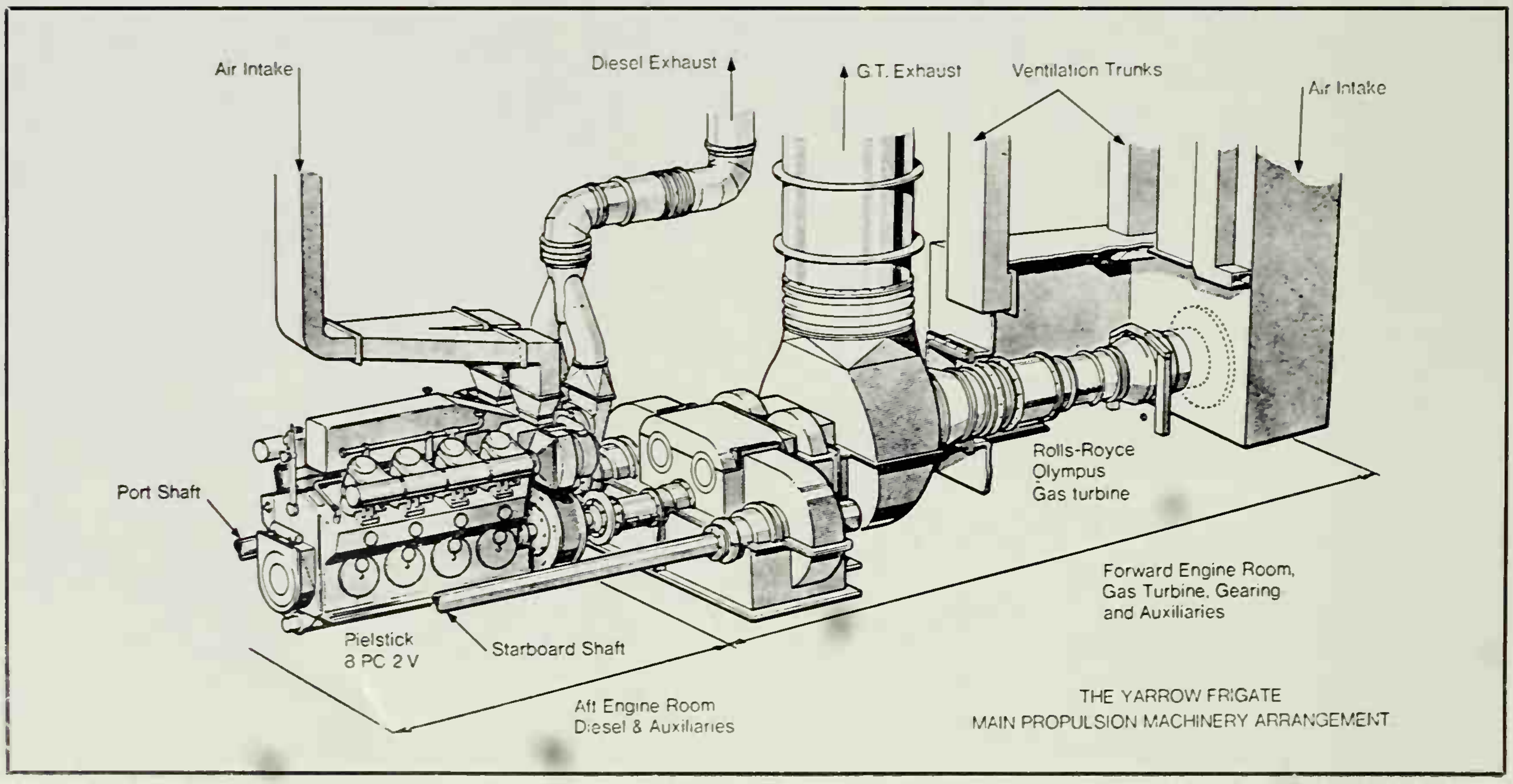
VOSPER THORNYCROFT
Shipbuilding Division
Vosper House, Paulsgrove, Portsmouth, Hampshire, England
Telephone: Cosham 79481 Telex: 86115

1969

YARROW (SHIPBUILDERS) LTD
Scotstoun, Glasgow W4, Scotland
Telephone: 041-959 1207 Cables: Yarship Glasgow
Telex: 77357

The clean lines of the Yarrow frigate are a promise of its economical performance and speed when required. Faster and more sophisticated than a corvette, smaller and more economical than a first-rate frigate, the Yarrow frigate provides powerful armament and control systems for general defence. Designed to help developing nations protect their own interests, the Yarrow frigate gives economy in capital cost, in operating cost and in vital operating manpower at about 60 per cent of the equivalent figures for existing first-rate frigates

The Yarrow frigate's twin-screw CODOG arrangement of fully automated machinery combines a single diesel engine of good specific fuel consumption giving high endurance and long-range cruising economy, with a large gas turbine of low specific machinery weight for high-speed operational performance. Normal cruising performance up to 16 knots is obtained from the Crossley-Pielstick PC2V engine driving through an automatic SSS synchronising clutch into a single gearbox from which two output shafts drive two controllable-pitch propellers. Running on distillate fuel, life between piston withdrawals will be 12 000h or more. Full control is exercised by independent change of propeller pitch, through simple lever controls on the bridge. At speeds above 16 knots, the Rolls-Royce Marine Olympus gas-turbine is started, and drives into the same gearbox through a separate SSS clutch


Air Intake
Diesel Exhaust
G.T. Exhaust
Ventilation Trunks
Air Intake
Rolls-Royce Olympus Gas turbine
Port Shaft
Forward Engine Room, Gas Turbine, Gearing and Auxiliaries
Pielstick 8 PC 2 V
Starboard Shaft
Aft Engine Room Diesel & Auxiliaries

THE YARROW FRIGATE
MAIN PROPULSION MACHINERY ARRANGEMENT

Frigates

with economical manning requirements

Compact, economic, versatile and powerful, the Yarrow frigate is a complete major fighting ship of an entirely new design filling the widening gap between the large Leander Class frigates and the small corvettes. Capable of matching first-line frigates in both fire-power and performance, the Yarrow frigate is available at about 60 per cent of their cost. The armament payload of 150 tons compares favourably with warships of twice the size.

Variations in design detail provide for fitting out the Yarrow frigate for general defence services or for specific duties such as anti-aircraft or anti-submarine operations.

There is an automatic pilot, fin stabilisers and direct bridge control of the main propulsion machinery.

The Yarrow frigate has a cruising range of more than 5000 miles at 16 knots, with a range of more than 1000 miles at full speed.

All living and operating compartments are fully air-conditioned and, with maintenance and operating duties kept to a minimum, most of the complement of 120 is available to man the armament.

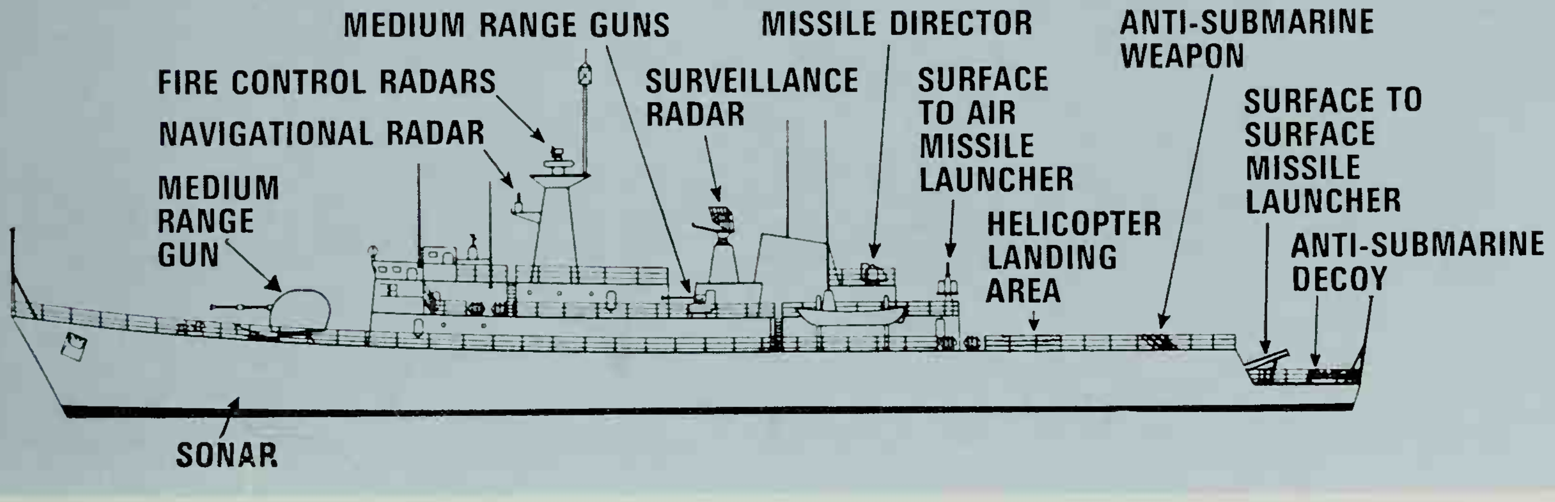
The main engines are fully automated and combine a single diesel with a large gas turbine, using the same easily obtainable standard diesel fuel.

Weapon and propulsion machinery variations are all to suit purchaser's requirements. A specialist team is available to visit any country to discuss the adaption of the Yarrow frigate to a specific defence requirement.

More than 100 years' experience of warship design and construction lie behind the Yarrow frigate. The modern Yarrow shipyard, with computer scheduling and control of work flow and covered building berths with all supporting services, can deliver a Yarrow frigate fitted out to the very high standard for which the company is famous, in less than three years.

Typical Yarrow frigate: dimensions, range and performance

Length: 94·5m (310ft)
Breadth: 10·3m (34ft)
Draught: 3·36m (11ft)
Maximum speed: up to 33 knots
Economical speed: 16 knots
Cruising range: more than 5000 miles
Full-speed range: more than 1000 miles
Complement: 120
Armament: as required



Weapon systems

The Yarrow frigate can be fitted with surface weapons to engage up to three surface and air targets using radar and computer facilities, with additional close-range defence in local control.

A choice of anti-submarine systems is fitted, using either mortar projectile rockets or torpedoes as required; in addition a helicopter can be carried to extend the anti-submarine capability, and for surface attack.

A choice of weapon control and action information systems using the latest Ferranti, Signaal or Contraves computers is offered, together with modern radar, sonar and communications equipment.

Typical weapons which can be fitted include surface-to-surface missiles (Penguin, Sea Killer), surface-to-air missiles (Indigo, Seacat, Seaset, Sea Sparrow), medium-range mountings (Bofors L46 120mm, Oto Melara 127/54, Vickers 4·5-in Mk 8), close-range mountings (Bofors 40mm and 57mm, Oto Melara 76/62, Oerlikon twin 35mm), anti-submarine weapons (Asroc, Bofors rocket launcher, Mortar Mk 10, Terne, torpedoes), etc.

A feasibility study of alternative weapon fits can be carried out on request.

YARROW (SHIPBUILDERS) LIMITED
Scotstoun, Glasgow W4, Scotland
Telephone: 041-959 1207 Cables: Yarship Glasgow Telex: 77357

Type 42 destroyer

multi-role guided missile vessel

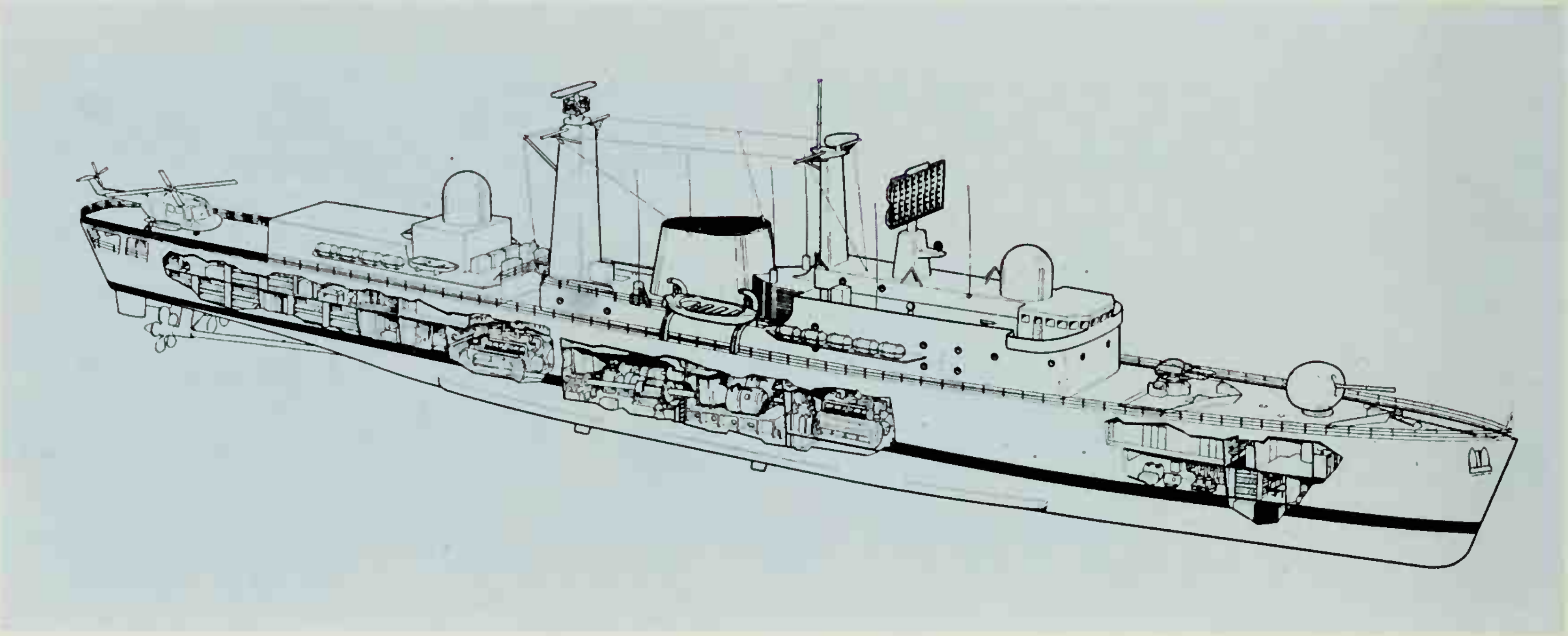
The gas-turbine propelled Type 42 destroyer has been designed to provide all-round support for the modern naval fleet. The machinery, outfit, and weapon systems have been selected as being the most cost-effective to meet operational requirements, and emphasis has been on minimising running costs and in-service support during the ship's life.

A combined gas-and-gas (COGOG) machinery arrangement has been specified, using Olympus engines for full-power conditions and Tyne engines for cruising. The benefits of the COGOG arrangement, proved in service, include rapid ability to reach top speed, reduced space and weight, and savings in technical manpower.

The Type 42 machinery and equipment assist in meeting the high standards of reliability and maintenance required by navies. The Type 42 has been designed to operate world-wide with a minimum of dockyard support between the planned four-yearly refits. To minimise on-board maintenance, a repair-by-replacement policy has been widely adopted. Items too large for planned replacement such as main gearing or Olympus engines have been designed for long life and very high reliability.

Lubrication, power supplies, and machinery control systems have been designed to minimise interdependence, and fail-safe principles are employed. Also, normal sea-going conditions do not require all diesel generators and air-conditioning plants to be on load simultaneously, thus allowing further margins for maintenance. Pipe systems, too, have been kept as simple as possible, and the number of underwater fittings reduced to a minimum.

The main armament of the Type 42 is the Sea Dart guided missile, providing the main air-defence role of the ship. For surface engagement and further anti-aircraft armament, a Mk 8 4·5-inch gun is fitted. Both Sea Dart and Mk 8 are linked to tracker illuminator radars and a controlling computer. For anti-submarine warfare duties, the Type 42 carries the latest sonar systems and the WG13 helicopter armed with homing torpedoes or guided missiles.



The Royal Navy's first Type 42 destroyer will be delivered early in 1972. Vickers has been nominated as lead yard for the class

Specification

Dimensions
Length: 119·5 m (392 ft 0 in)
Breadth: 14·0 m (46 ft 0 in)
Depth: 9·0 m (29 ft 6 in)
Draft, deep condition: 4·0 m (13 ft 0 in)
Displacement, deep condition: 3675 tons

Main machinery
Two Rolls-Royce Olympus 50 000 shp—high speed
Two Rolls-Royce Tyne 7000 shp—cruising
Coupled in a COGOG configuration through non-reversing reduction gearboxes and driving twin controllable-pitch propellers

Performance
Max speed: over 28 knots
Range: about 8300 km (4500 nm)

Accommodation
For 315 officers and men

Armament
Sea Dart guided missile system Mk 30 Mod 2
One 4·5-in Mk 8 Vickers gun mounting
Two 20 mm Mk 7A Oerlikon mountings
WG13 helicopters armed with homing torpedoes or guided missiles
Two Mk 32 single torpedo tubes
FM1600 computer, and associated systems
Designers: Ministry of Defence (Navy), Bath
Main contractors: Vickers Shipbuilding Group, Barrow-in-Furness
Main sub-contractors: Rolls-Royce, Hawker Siddeley Dynamics, Ferranti, Plessey, Westland, David Brown Gear Industries, Stone-Manganese Marine

VICKERS SHIPBUILDING GROUP
Barrow Shipbuilding Works
PO Box 6, Barrow-in-Furness, Lancashire, England
Telephone: Barrow-in-Furness 20351 Cables: Vicarmsea Barrow-in-Furness
Telex: 6571

Vickers

Section 2

Support vessels

HMS *Beagle*

Principal particulars and abridged specification

Hull form

Round bilge with knuckle forward and aft. Optimum prismatic coefficient and bulbous bow fitted, giving excellent sea-keeping qualities and good flow into propellers

Construction

All-welded mild steel hull with aluminium alloy superstructure. Watertight sub-division to meet two compartment flooding requirements

Classification

Lloyds ✠100A1. Lloyds Machinery Certificate

Propulsion

Four Lister Blackstone ERS8M marine diesel engines driving twin CP propellers through twin-input single-output reduction gearboxes

Performance

Four engines (two engines per shaft) maximum bhp 2640 at 750rev/min
Maximum speed 15 knots

Two engines (one engine per shaft) maximum bhp 1320 at 750rev/min
Maximum speed 11¾ knots

The above figures given for the ship in the deep condition under UK conditions

Range

Four engines running, speed 15 knots, range 2000 nautical miles

Two engines running, speed 11¾ knots, range 4500 nautical miles

Tank capacity

Fuel 104 tons
Fresh water 52 tons

Operational spaces

Wheelhouse
Plotting room
Chart room
Main survey room

Survey and navigational equipment

Decca Hi-Fix type BM
Decca Mk. 12 Survey Receiver
Decca type TM 62S Radar
Kelvin Hughes Fisherman's Asdic Mk. 11
Three Kelvin Hughes MS 26 Echosounders
Electronic Chernikeef Log

Boats

One 8·7m (28ft 6in) Danielle survey boat with Hi-Fix receivers and echosounder
One 5·5m (18ft) GRP survey boat with echosounder
One Gemini inflatable dinghy
One 3·6m (12ft) dinghy

Electrical system

440V, 3-phase 60Hz
Four 225kVA alternators
One 36kVA alternator for emergency and harbour use

Steering gear

Electro-hydraulic steering gear with hand and auto steering systems operating twin spade rudders

Deck machinery

All deck machinery powered by an electro-hydraulic system
Windlass 6¼ ton at 9m/min (30ft/min)
Capstan 2 ton at 23m/min (75ft/min)
Deck crane 1½ ton maximum radius 7m (22ft 9in)

Stabilisation

Passive stabilisation tank fitted giving 60% roll reduction

Accommodation

Arranged for a total complement of 43 men
Commanding officer, en suite dayroom, night cabin and toilet
Six officers, two single cabins, four double cabins
Eight senior ratings in four double cabins
Twenty-eight junior ratings in dormitory forward
Self service laundry, library, canteen, sick-bay and cinema

Air conditioning

All living spaces and certain working spaces air-conditioned to maintain internal temperatures of 18–30°C in ambient conditions of –4°C to +45°C

Self support

Vessel fitted with workshops and storerooms enabling the vessel to operate for periods up to 10 months without base support

Two evaporators each having a capacity of five tons/day fitted to augment FW capacity

Other features include provision of diving equipment, photographic dark room, Land Rover stowage on upper deck, a marine defecamet plant for sewage disposal and a helicopter dropping area on the quarterdeck

Key to diagrams on facing page

LOWER DECK

1	Bosun's store
2	RU survey store
3	Diving store
4	Spare gear store
5	De-gaussing equipment
6	Generator room
7	Generators
8	Engine control room
9	Engineers' workshop
10	Engine room
11	Main engines
12	Platform deck
13	Stabiliser tank
14	Class II cabin
15	Baggage store
16	Ship's office
17	Class IV cabin
18	Senior ratings' cabin
19	Senior ratings' baggage store
20	Regulating office
21	WC
22	Toilet
23	Junior ratings' bunk space

MAIN DECK

24	Helicopter dropping zone
25	Gemini dinghy
26	Dinghy
27	Portable plate (P&S)
28	Battery charging room
29	Potato and vegetable room
30	CO_2 room
31	Hydraulic pump room
32	Upper deck store
33	Woodworking compartment
34	Emergency generator and switchboard room
35	Senior ratings' mess
36	Galley
37	Pantry
38	Junior ratings' dining and recreation space
39	Laundry
40	Drying room
41	Paint room
42	Ante-room
43	Ward room
44	Pantry
45	Sick bay
46	Control communications switchboard room
47	Canteen and store
48	Magazine
49	Gunners' store

FORECASTLE DECK

50	Surveying instrument room
51	Hi-Fix compartment
52	Inflammable locker
53	5·5m (18ft) boat
54	8·7m (28ft 6in) survey boat
55	Surveying chartroom
56	Radio room
57	Sound reproduction room
58	CO's toilet
59	CO's dayroom
60	CO's bedroom
61	1½-ton crane
62	Hydraulic windlass
63	Anchor davit

BRIDGE DECK

64	Funnel
65	Air conditioning room
66	Plotting table
67	Chart table
68	Wheelhouse
69	20mm Oerlikon (P&S)

TANK TOP

70	Provision store
71	Victualling store
72	Dark room
73	Naval store
74	Gyro compass room
75	Wardroom store
76	Defacamet
77	Cold store and refrigerator
78	Refrigerator machinery
79	Hold
80	Asdic and log compartment under

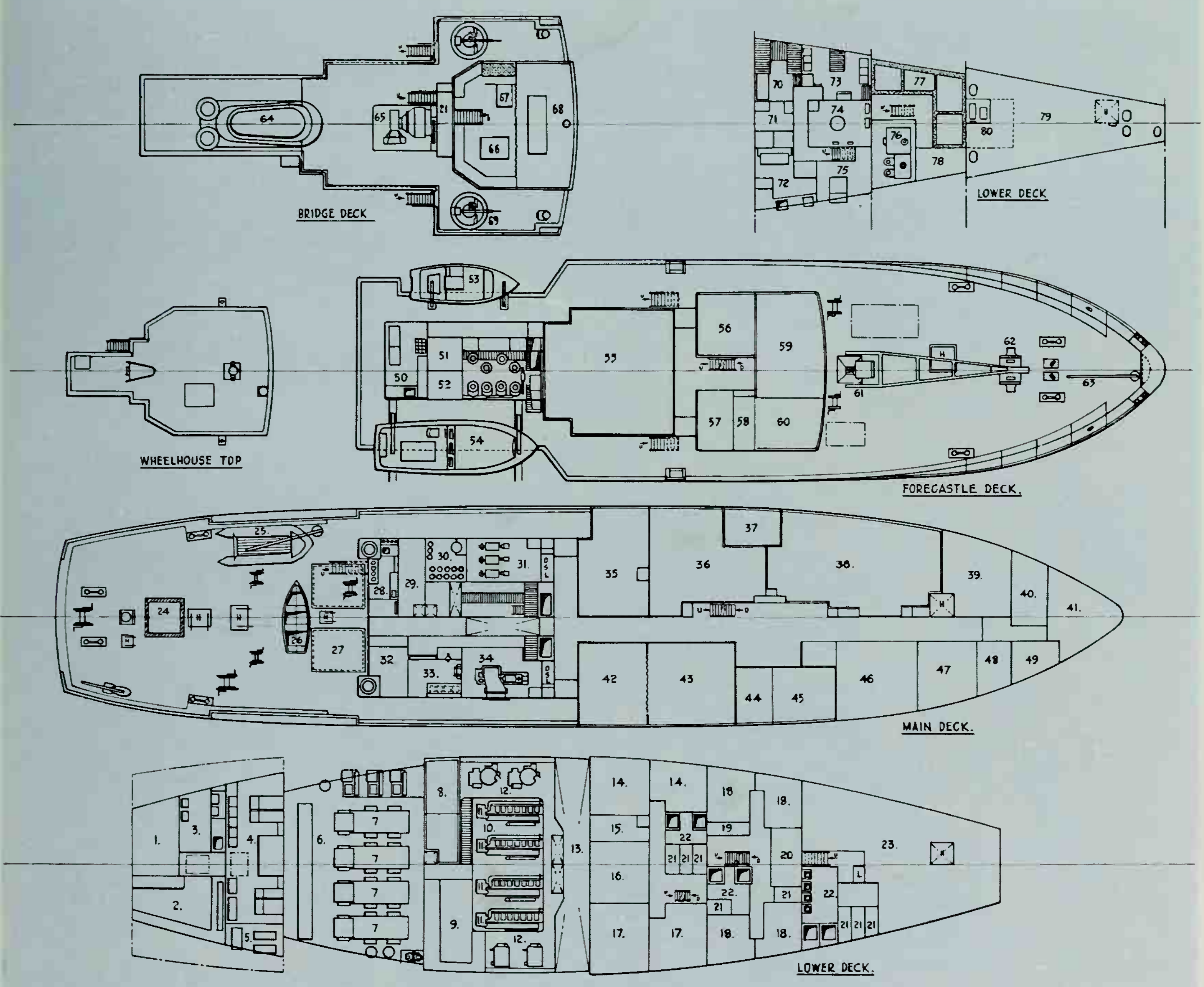
New survey craft

In August 1966 Brooke Marine Ltd were commissioned to design and build four survey craft for the Ministry of Defence (Navy) to carry out hydrographic survey work. A high standard of performance and quality has been achieved. The craft have been built to Lloyds Register Special Survey and certain MOD (Navy) standards. These craft, working in pairs, can operate for a two-year period between refits and operate for periods of ten months without base support. Excellent sea-keeping qualities to provide a stable working platform for the hydrographic work have been incorporated in their design.

The propulsion machinery arrangement is such that maximum efficiency is achieved under all conditions of operation, and the controls have been designed for simplicity of operation, reducing watchkeeping duties to a minimum.

The vessel has a maximum speed of 15 knots and when running on one engine per shaft has a range of 4500 miles at $11\frac{3}{4}$ knots.

In view of the requirement for long operations without base support, the standard of accommodation and amenities is very high and all living spaces and certain working spaces are fully airconditioned to allow operation in extremes of temperature from Arctic cold to equatorial heat. The vessels are the most advanced of their type, being fitted with the most modern surveying equipment and survey boats for special inshore work.


BRIDGE DECK
LOWER DECK
WHEELHOUSE TOP
FORECASTLE DECK.
MAIN DECK.
LOWER DECK.
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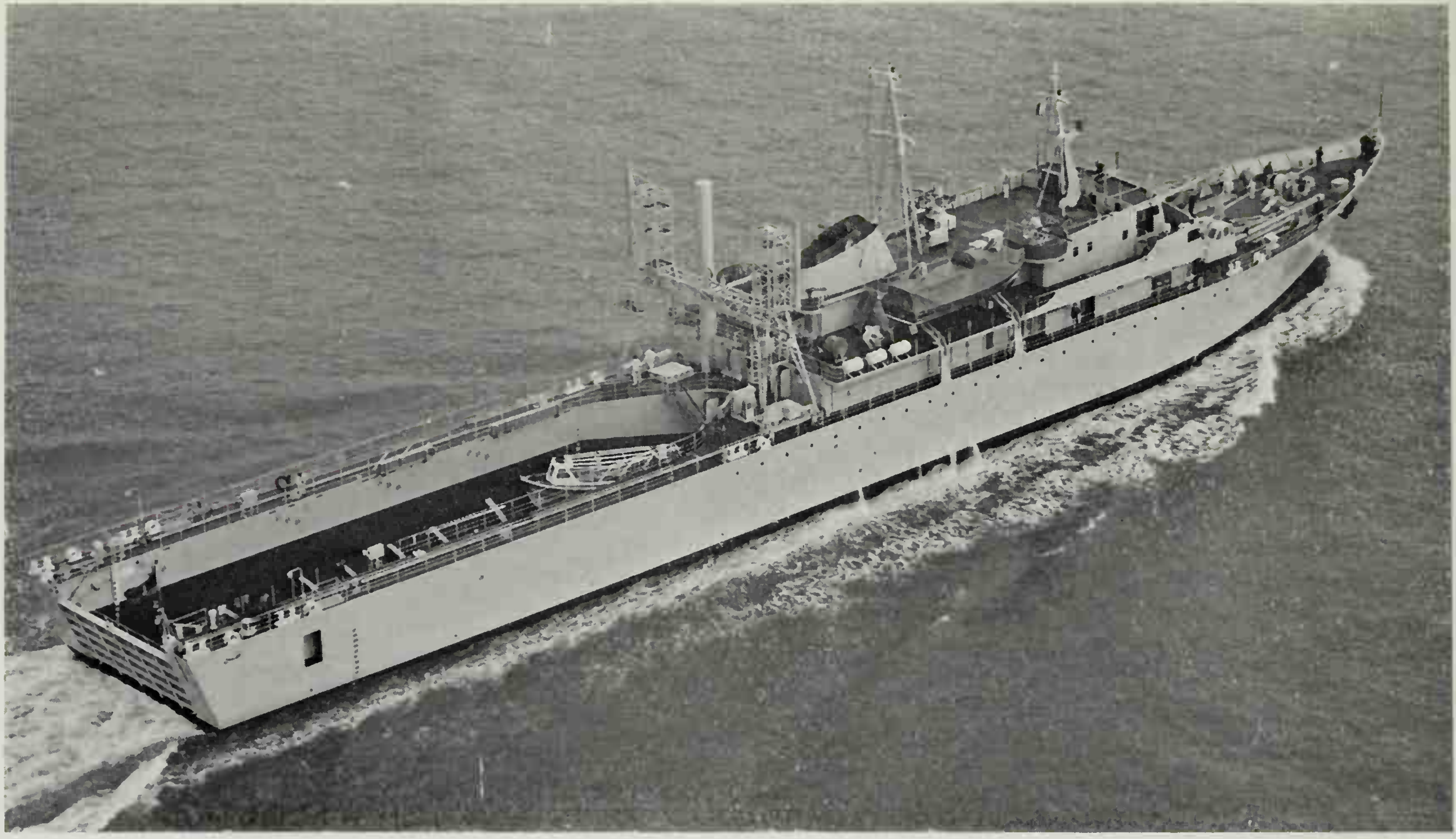
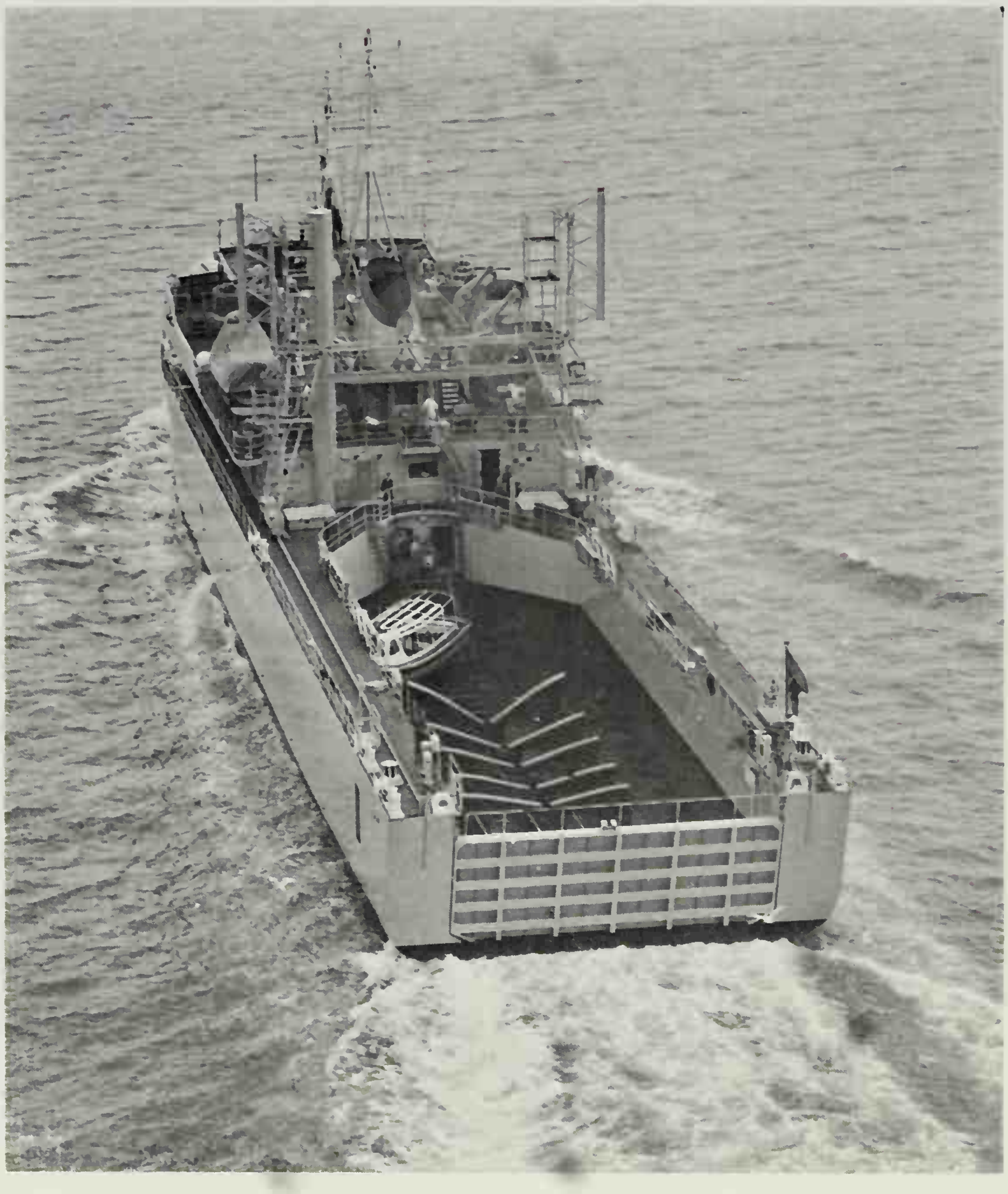
Dimensions

Length overall	57·7m	(189ft 6in)
Length between perpendiculars	51·4m	(168ft 6in)
Breadth moulded	11·4m	(37ft 6in)
Depth moulded	6·0m	(19ft 9in)
Maximum draft	3·8m	(12ft 6in)

BROOKE MARINE LIMITED
Lowestoft, Suffolk, England
Telephone: Lowestoft 5221 Cables: Brookcraft Lowestoft Telex: 97145



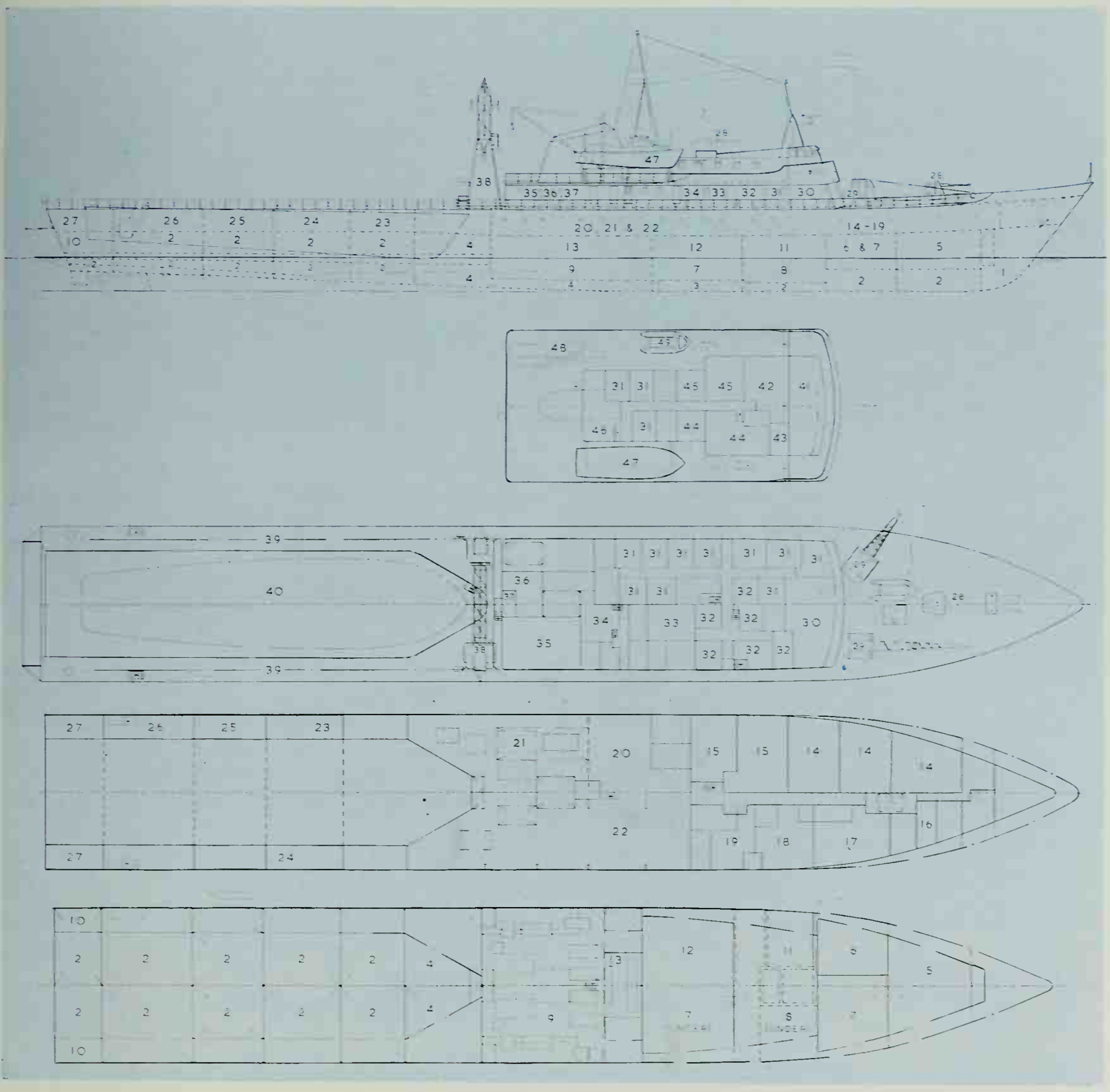
The MRS (maintenance and repair ship) *Zeltin*



A maintenance and repair ship of some 2400 tons displacement has been specially designed to meet the requirements of the Libyan Navy for a mobile naval base. The *Zeltin* was completed in 1968 at the Woolston shipyard. This ship provides a complete overhaul and maintenance capability for the fast patrol boat squadron and for the corvette *Tobruk*, training and recreational facilities for the boats' crews and accommodation for the operational staff. She is fitted with a dock for the fast patrol boats, and carries ample stocks of fuel, water, ammunition and stores for squadron use

Maintenance and repair ship

for corvettes and patrol boats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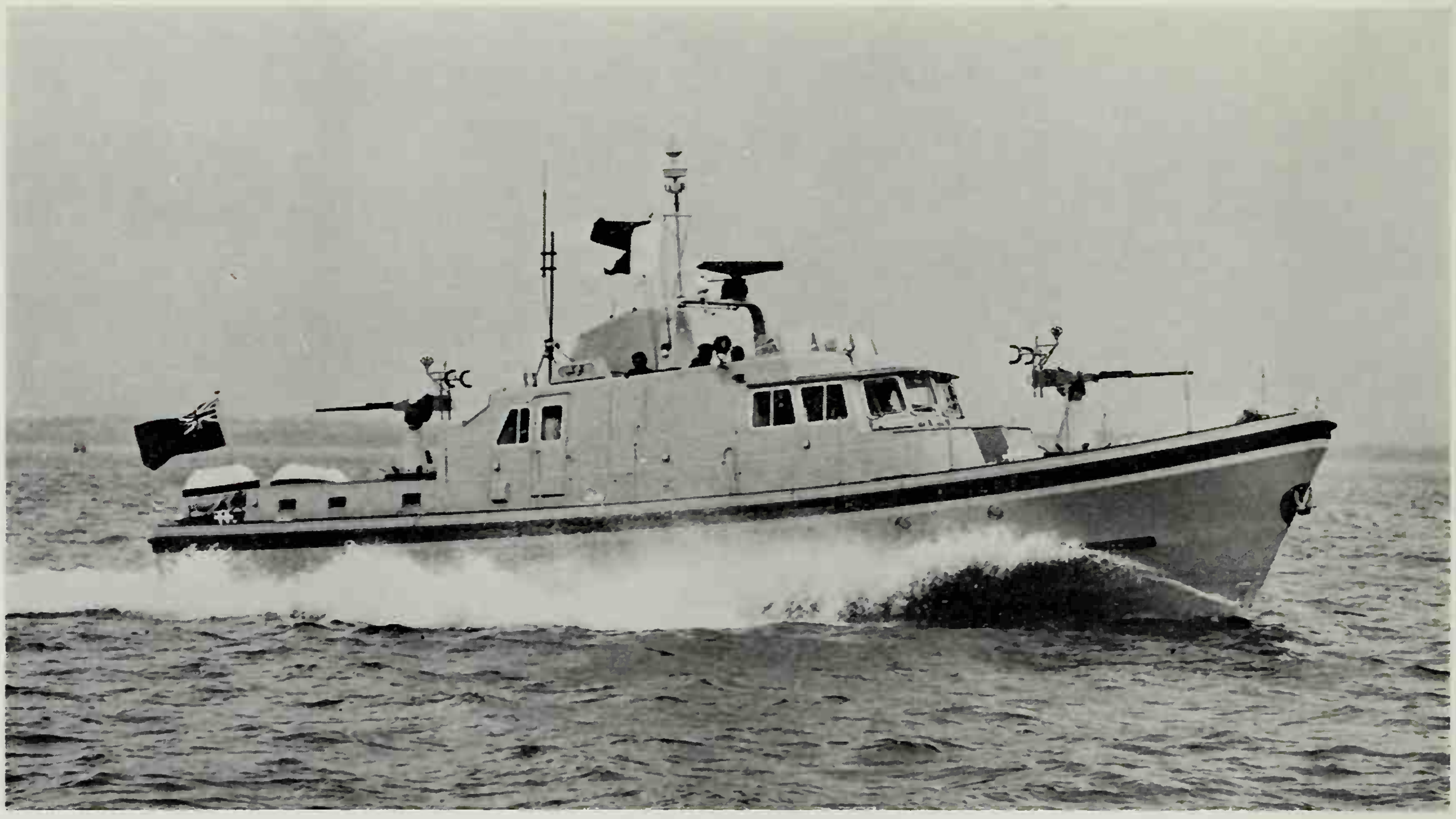
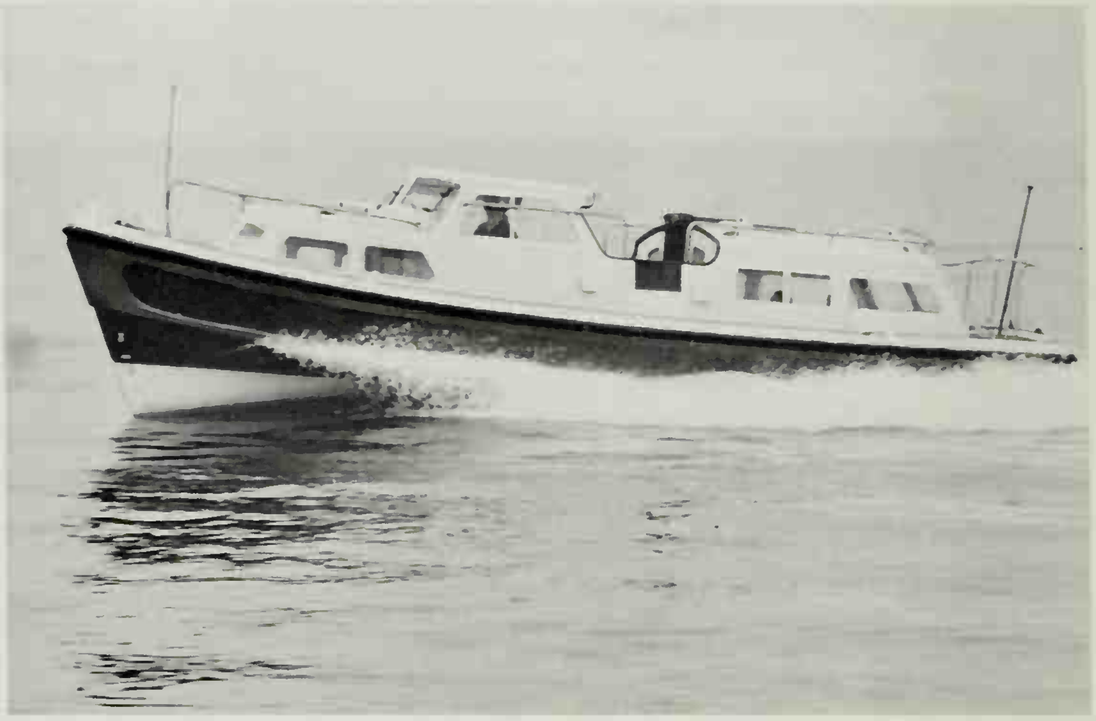
1	Fore peak
2	Water ballast tanks
3	Fresh water tanks
4	Oil fuel tanks
5	Store rooms
6	Magazine
7	Spare gear store
8	Refrigerated spaces and provision rooms
9	Engine room
10	Steering gear compartment
11	Cinema and lecture room
12	Radio and electrical workshops
13	Engine control room
14	Junior ratings' mess
15	Enclosed messes for chief petty officers and petty officers
16	Laundry
17	Junior ratings' dining hall
18	Galley
19	Senior ratings' dining hall
20	Machine shop
21	Engineering workshop
22	Platers' and plumbers' workshop
23	Engineers' store
24	Ship's store
25	Riggers' store
26	Stern door lifting machinery compartment
27	Capstan motor compartment
28	40mm Bofors guns
29	2-ton crane
30	Wardroom
31	Officers' cabins
32	Administration office
33	Sick bay
34	Maintenance office
35	Woodwork shop
36	Emergency generator room
37	Pump control room
38	Travelling 3-ton gantry
39	Rails for gantry
40	Dock
41	Wheelhouse
42	Operations room
43	Wireless office
44	Commodore's suite
45	Captain's suite
46	Commodore's operations room
47	10·36m (34ft) motor launch
48	9-ton derrick
49	Inflatable dinghy

VOSPER THORNYCROFT
Shipbuilding Division
Vosper House, Paulsgrove, Portsmouth, England
Telephone: Cosham 79481 Telex: 86115

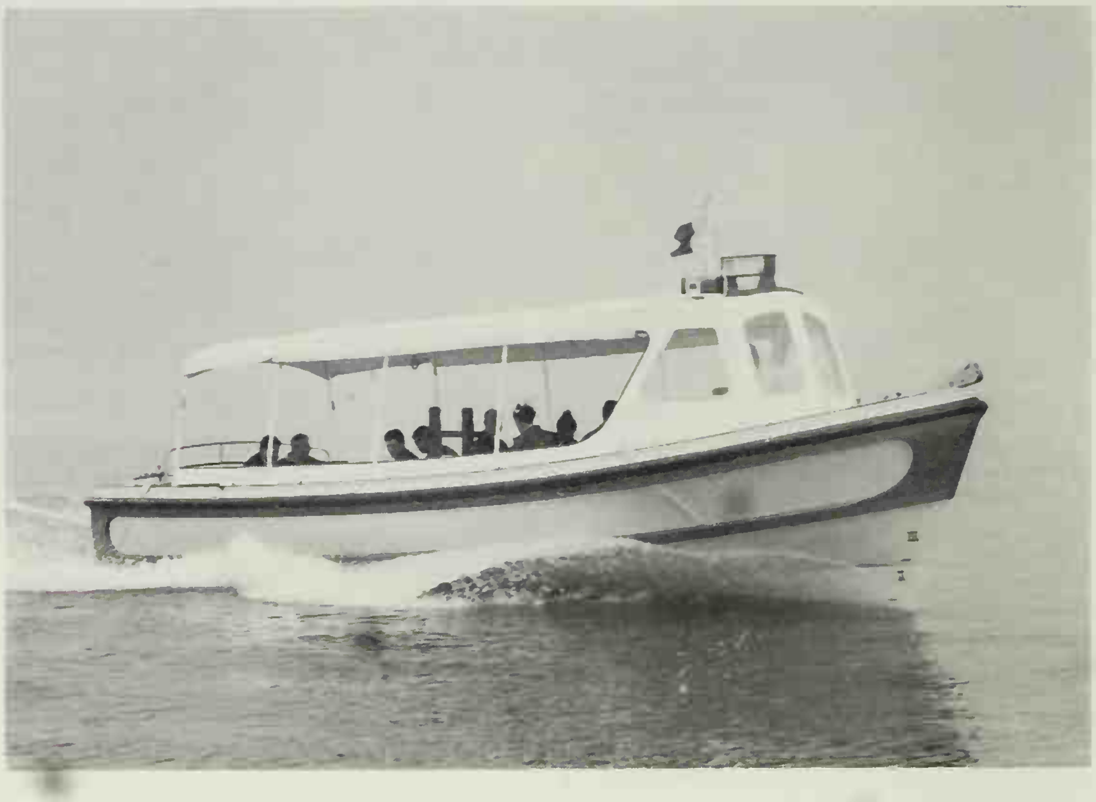
1966
1969



The 17 m (56 ft) patrol boat
Length overall 17·37 m (57 ft 0 in)
Length on waterline 15·84 m (52 ft 0 in)
Beam 5·03 m (16 ft 6 in)
Draft 1·33 m (4 ft 4½ in)



The 10 m (34 ft) personnel launch
Length overall 10·38 m (34 ft 0 in)
Length on waterline 9·45 m (31 ft 0 in)
Beam 3·03 m (10 ft 0 in)
Draft 0·92 m (3 ft 0 in)
Twin- or single-screw machinery is available



The 10 m (34 ft) open work boat
Length overall 10·38 m (34 ft 0 in)
Length on waterline 9·45 m (31 ft 0 in)
Beam 3·03 m (10 ft 0 in)
Draft 0·92 m (3 ft 0 in)

Launches and boats

Nelson craft with glass-reinforced plastics hulls

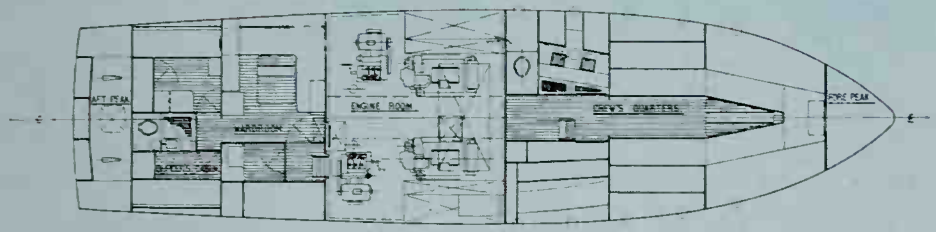
The well-known boat building company Keith Nelson & Co Ltd of Bembridge in the Isle of Wight, England, has joined the Vosper Thornycroft Group and transferred its headquarters to Portsmouth. In so doing it has extended the range of craft that the Group can offer to include a number of extremely sophisticated boats of the most up-to-date design in the 10–18 m (34–60 ft) range.

Theoretical study and long practical experience in all weather conditions have produced the standard Nelson hulls of various carefully chosen sizes. They are of round bilge form and constructed in glass-reinforced plastics (GRP) to give both high performance and good seakeeping. The structure is of exceptional strength, with built-in tanks and watertight subdivision. GRP has the considerable additional advantages that it is not liable to rot or corrode or suffer damage from marine borers and that structural damage can be quickly and easily repaired. Routine maintenance of the hull is reduced to a minimum.

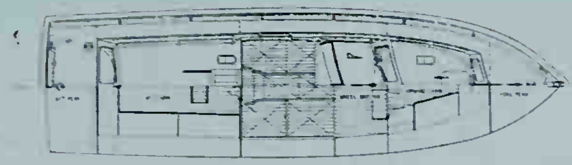
The 18·3 m (60 ft) hull has been developed from the 17 m (56 ft) boat for use as a patrol craft, with or without a light armament. These boats are suitable for such duties as coastal patrol, anti-smuggling or air-sea rescue in open waters.

The Keith Nelson 12 m (40 ft) hull, which has been used extensively for patrol boats, pilot boats, personnel launches, etc, over the last five years, has now been redesigned to be 13·7 m (45 ft) in length with a corresponding increase of about 0·3 m (1 ft) in beam.

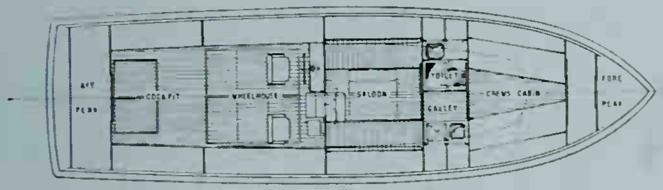
The length of 10·3 m (34 ft) was selected as the smallest twin-engined boat that can carry a dozen passengers or a ton of stores at a speed of about 20 knots in an open anchorage in any reasonable weather.



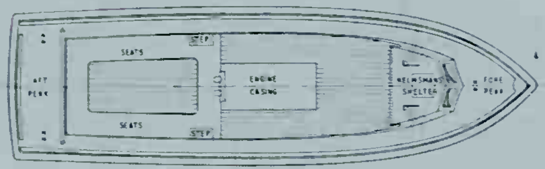
The 18·3 m (60 ft) patrol craft



The 10 m (34 ft) personnel launch



The 13·7 m (45 ft) patrol craft



The 10 m (34 ft) work boat

The 12 m (40 ft) patrol launch
Length overall 12·52 m (41 ft 2 in)
Length on waterline 11·68 m (38 ft 4 in)
Beam 3·61 m (11 ft 10 in)
Draft 0·99 m (3 ft 3 in)

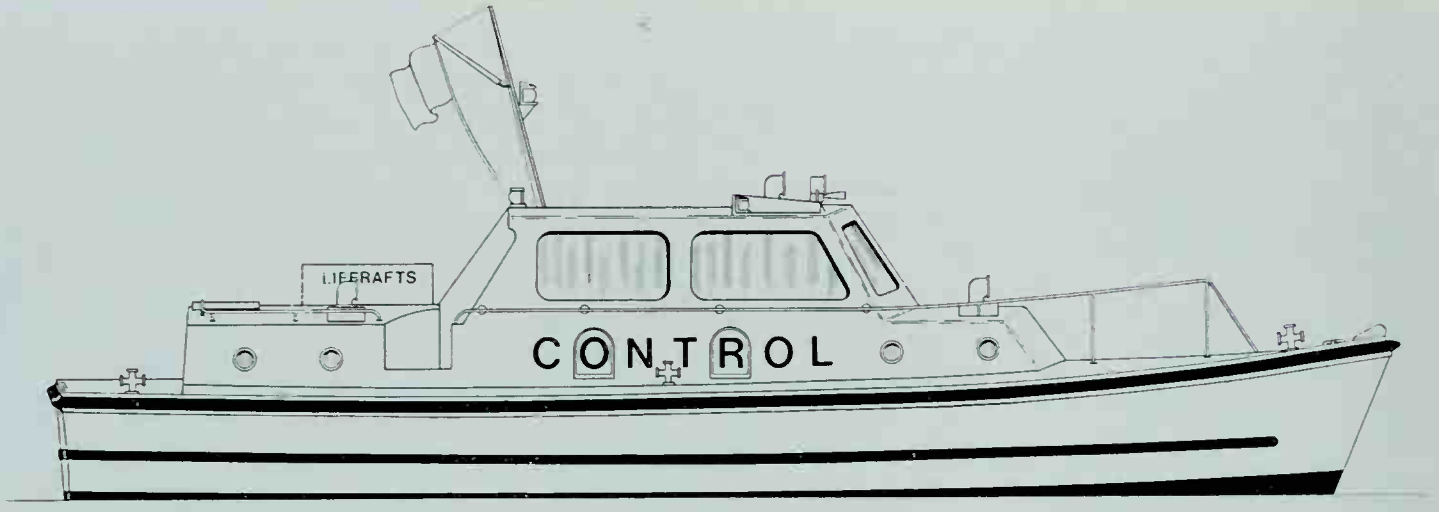
VOSPER THORNYCROFT
Shipbuilding Division
Vosper House, Paulsgrove, Portsmouth, England
Telephone: Cosham 79481 Telex: 86115

1966
1969

Patrol and rescue craft

in glassfibre-reinforced plastics

Two examples of a range of fast, tough boats built in glassfibre-reinforced plastics. Standard hull lengths rise from 7·62 m (25 ft) to 25·90 m (85 ft). Built by Halmatic Limited in their quality-controlled factory to Lloyd's specifications, these craft are supplied to navies, public authorities and commercial firms throughout the world.

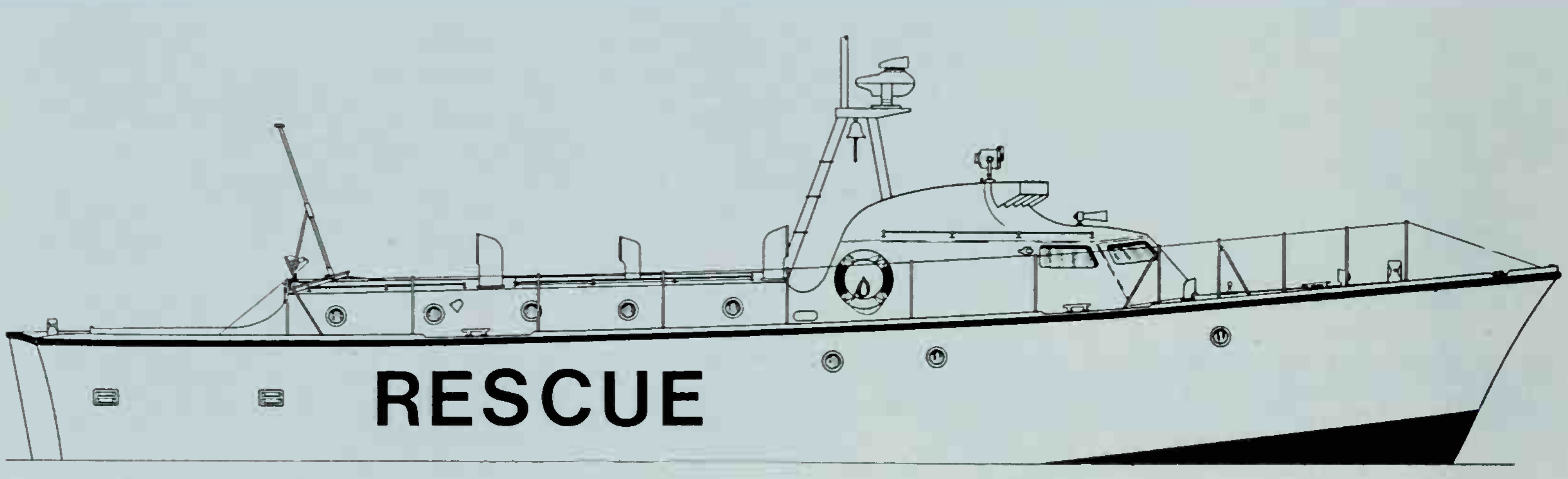


12·2 m (40 ft) command and control vessel

Specification

A round-bilged, semi-planing hull with proved seakeeping qualities. Over 70 boats of this type have been produced and many are now in service with navies and pilotage authorities all over the world. The latest version has an all-glassfibre-reinforced plastics hull, deck and superstructure built to Lloyd's requirements.

Length, overall: 12·28 m (40 ft 4 in)
Length, waterline: 11·68 m (38 ft 4 in)
Beam, moulded: 3·35 m (11 ft)
Draught: 0·99 m (3 ft 3 in)
Displacement: 9200 kg (20 000 lb)
Fuel capacity: 1450 litres (218 gal)
Range, cruising: 725 km (390 nm)
Engines: 2 Cummins V8 185, 175 bhp
Speed: maximum 20 knots cruising 18 knots,
Designers: TT Boat Designs



19·5 m (64 ft) air/sea rescue craft

Specification

A fast hard-chined hull in glassfibre-reinforced plastics, developed over the years from a range of well-proved motor torpedo boats. A very seaworthy and stable hull which can be used as a patrol vessel, fast passenger carrier or fishery protection vessel, as well as for many other purposes.

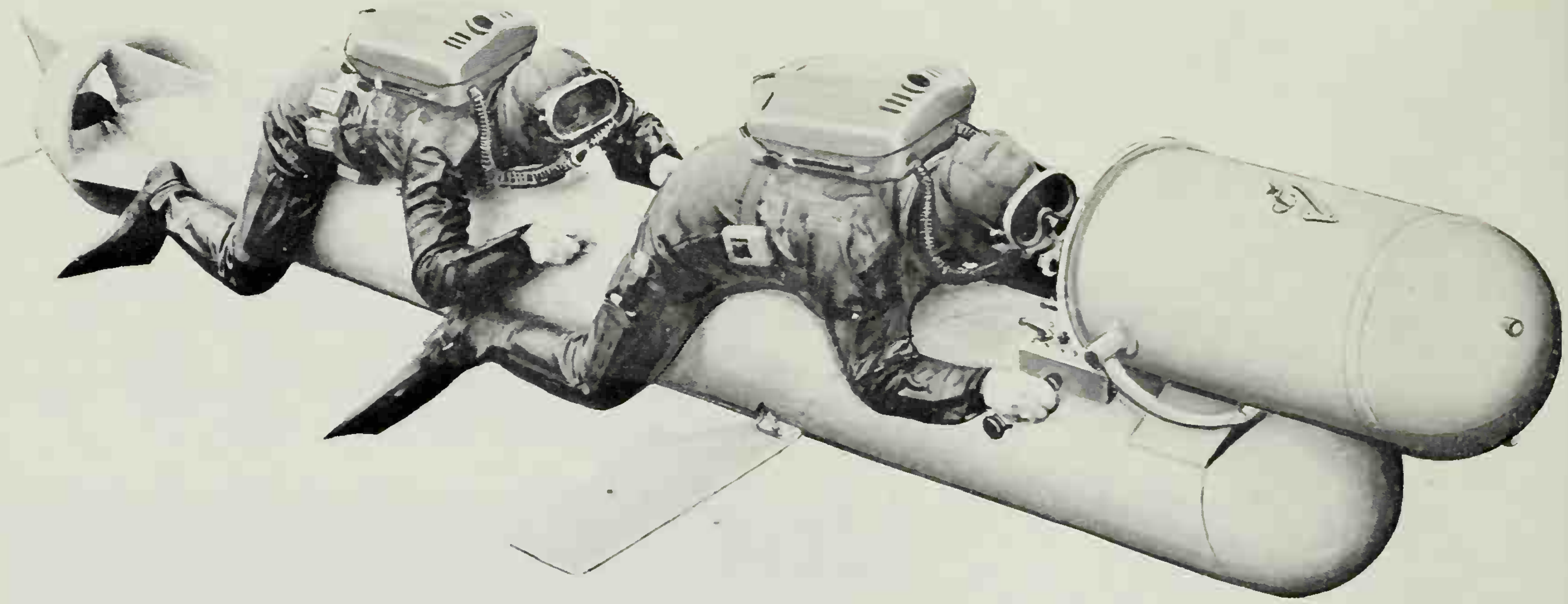
Length, overall: 19·56 m (64 ft 2 in)
Length, waterline: 17·90 m (58 ft 9 in)
Beam, moulded: 4·98 m (16 ft 4 in)
Draught: 1·45 m (4 ft 9 in)
Displacement: 31 700 kg (70 000 lb)
Fuel capacity: 6280 litres (1380 gal)
Range, cruising: 1000 km (550 nm)
Engines: 2 Rolls-Royce DV8, 715 bhp
Speed: maximum 26 knots, cruising 22 knots
Designer: J B Hargrave

HALMATIC LIMITED
Havant, Hampshire, PO9 1JR, England
Telephone: Havant 6161

Hunting

Section 3

Underwater vessels, weapons and equipment

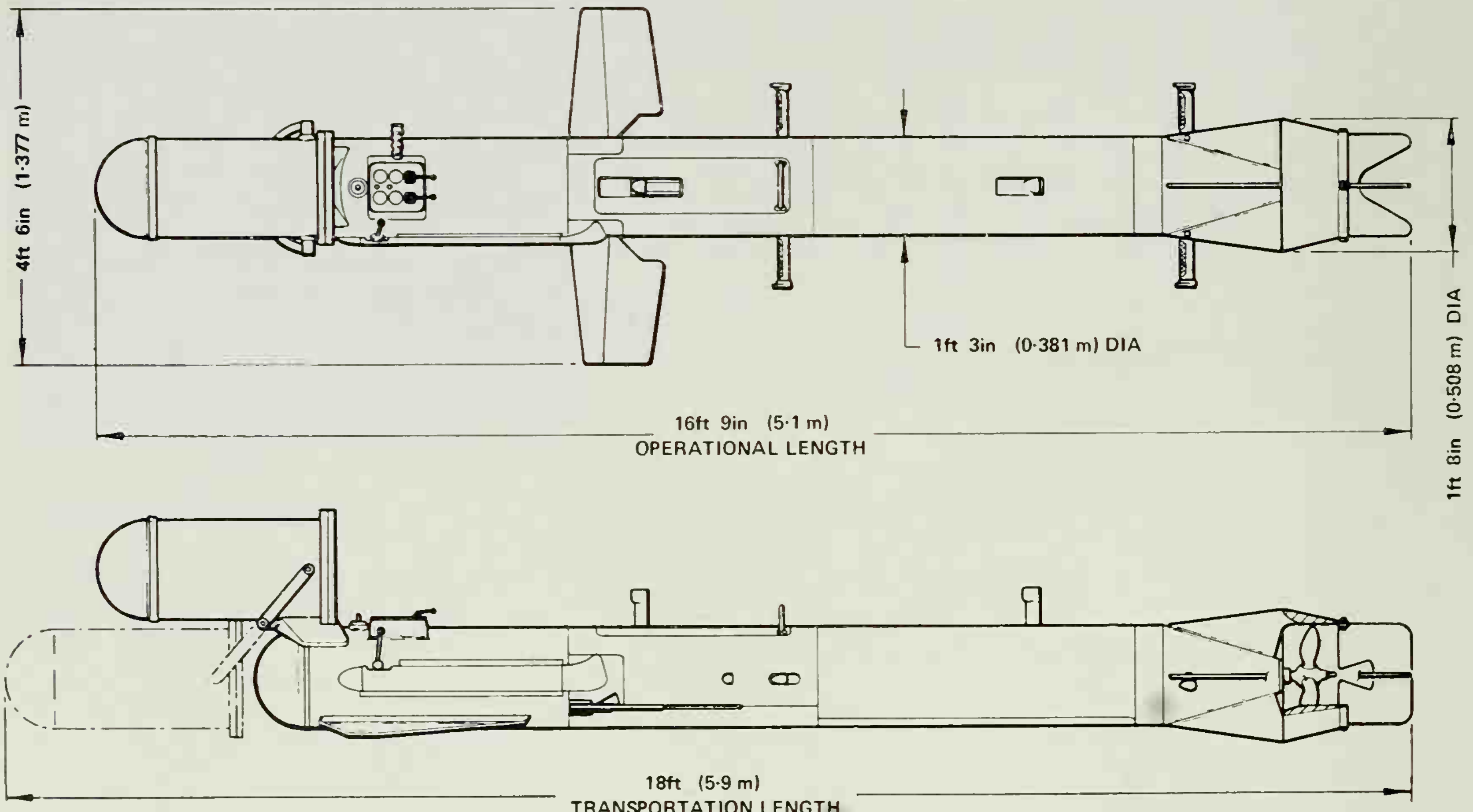


As can be seen from the illustrations on this page, the Type B is a vehicle in which the divers are exposed. It is intended for much the same purpose as the A2; the performance figures and technical details are given in the specification below.

Marex can supply instructors to give comprehensive courses on their submersible vehicles in any part of the world. The installation of a diving unit can be carried out, together with the supply of diving equipment. Marex also offers a replacement parts service. Experienced consultants are available to advise on any operational and maintenance problems.

Specification

Dimensions:
  Length, transportation: 5·9 m (18 ft)
  Length, operational: 5·1 m (16 ft 9 in)
  Maximum diameter: 0·508 m (1 ft 8 in)
  Overall width: 1·377 m (4 ft 6 in)
  Overall height: 0·84 m (2 ft 9 in)
Maximum operating depth: 60 m (200 ft)
Instrumentation:
  Main body:
  Ammeter: current taken from battery, amperes battery state indicator (2 off): volts, propeller pitch indicator; degrees forward and reverse
  Console:
  Depth gauge, needle indication –0 to 80 m
  Compass, vertical display, degrees
  Log, digital display, reset: 1/100 nautical miles
  Speed indicator, needle indication: knots
  Echo sounder, forward/downward: metres
  Clock (running time); digital, reset: hours/min/sec
  Clock (total time, digital, reset: hours/min/sec
Power supply: normal operations silver/zinc batteries 600 Ah; restricted operation 300 Ah
Carrying capacity: compartment for neutrally buoyant equipment, approx 0·05 m³ (1¾ ft³)
Weight: basic weight 170 kg (380 lb); weight including batteries 270 kg (600 lb)
Speed: cruise speed 3 knots (5·5 km/h); max speed 5 knots (9·2 km/h)
Endurance:
  at 2 knots (3·7 km/h) 15 hours
  at 3 knots (5·5 km/h) 8 hours
  at 4 knots (7·4 km/h) 5 hours
  at 5 knots (9·2 km/h) 3 hours



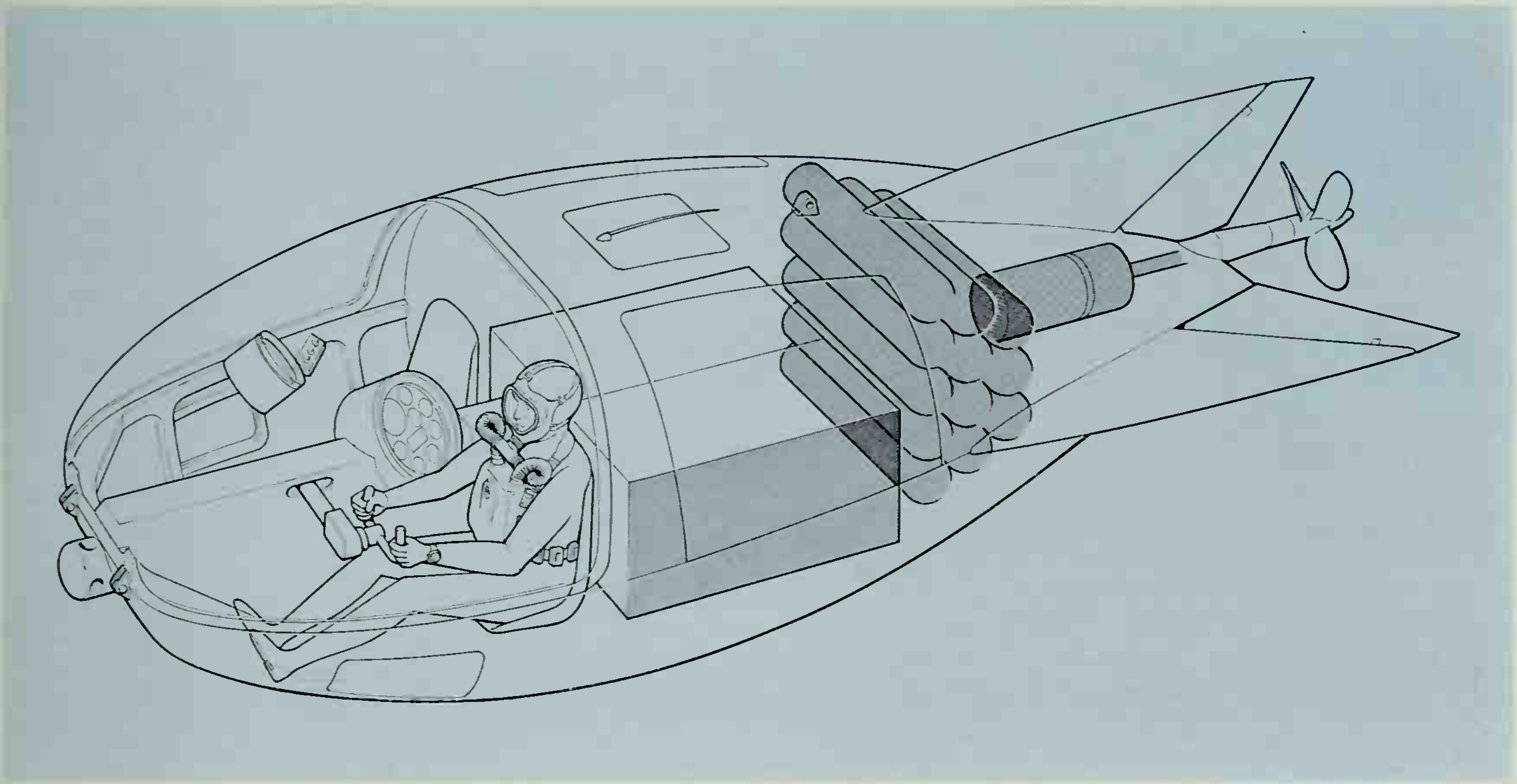
DIVER TRANSPORT VEHICLE TYPE B
General Arrangement

Diver transport vehicles

Marex Type A2 and B

The A2 diver transport vehicle is of a new design especially for military survey and surveillance, attack swimming and carrying divers to strategic areas. A variable-speed dc motor through a high-efficiency gearbox and a large low-speed propeller gives the A2 very good endurance which is necessary from the safety aspect and to provide the necessary range for the vehicle.

A large plexiglass screen which protects divers from dynamic flow pressure ensures unobstructed vision in all directions but astern. The controls are straightforward and consist of an aircraft-type steering column which in turn operates rear-mounted stabilising fins to give depth and directional control. All the necessary levers for controlling the buoyancy, trim and speed of the vehicle are situated within easy reach of the pilot diver. The maximum operating depth is limited to 80 metres (250 ft). The physiology of the diver becomes a more important factor beyond this depth. The depth capability can be increased for specialist operations. The instruments of the A2 have been specially selected to provide maximum operational efficiency and are situated on the pilot diver's console, apart from the air/mixture and life support instrumentation which are to be found on the No 2 diver's console. Ample storage capacity is provided by twin lockers in the upper mid section of the vehicle. Handling is made easy by a single lifting eye positioned in the upper hull. The vehicle is balanced about this point, which enables it to be positioned manually once lifted by a crane; it can be secured to the transportation unit by quick-release clamps incorporated in the skids.

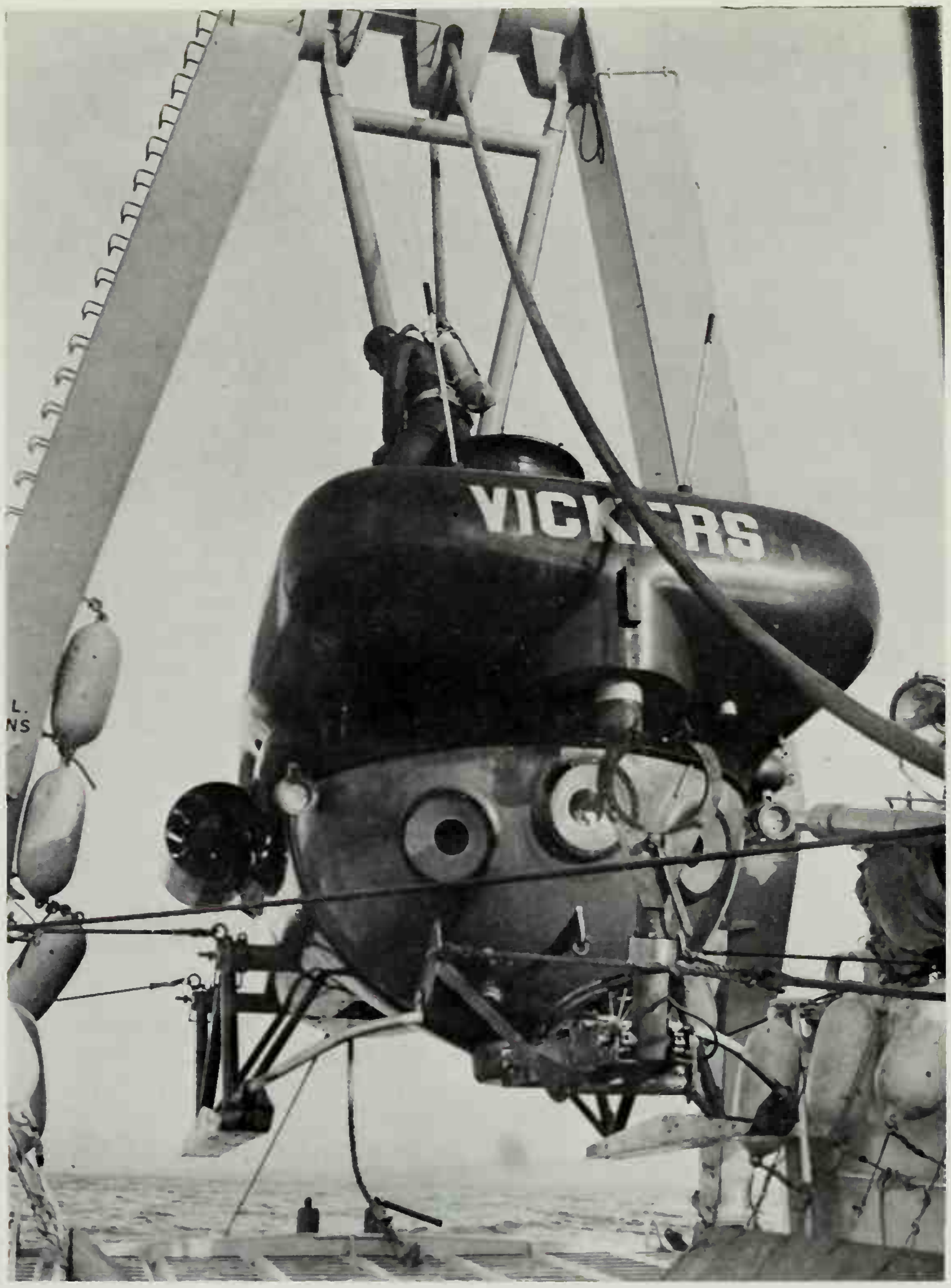


Specification

Dimensions:
  Length 4·90 m (16·1 ft)
  Height 1·42 m (4·6 ft)
  Beam 1·87 m (6·1 ft)
Maximum operating depth: 80 m (250 ft)
Operational weight: 2500 kg (2½ tons)
Speed: maximum 7 knots (13 km/h); cruise 5 knots (9·2 km/h)
Carrying capacity: twin storage lockers, total volume 0·3 m³; total weight 200 kg
Instrumentation:
  Pilot's console:
  Ammeter: current taken from battery
  Trim indicators: degrees nose up/down
  Motor rev/min indicator
  Voltmeter: volts
  Depth gauge: 0–80 m
  Compass: degrees
  Log, digital, reset: 1/100 nautical mile
  Speed: analogue
  Echo sounder forward/downward: metres
  No 2 diver's console:
  Clock, running time, total time: digital reset
  Motor temperature monitor: degrees C
  Ampere hour meter: power contents of battery
  Diving air/mixture contents indicator: bar
Life support: storage volume 42·5 m³ (1500 ft³)
Power supply: voltage 48 V dc; batteries: lead-acid type; capacity: 30 kWh
Endurance: 6 hours at cruise 5 knots (9·2 km/h)
  4 hours at max 7 knots (13 km/h)

MARINE EXPLORATION LIMITED
Marex House, High Street, Cowes, Isle of Wight, England
Telephone: Cowes 4731 Cables: Marex Cowes Telex: 86262

marex



The handling gear on Vickers Venturer will lift over 12 tons and provides compensation for ship and submersible motions in rough seas

Vickers-Pisces can be used in several naval roles, including:

Location and recovery of torpedoes and equipment

Inspection of wrecks

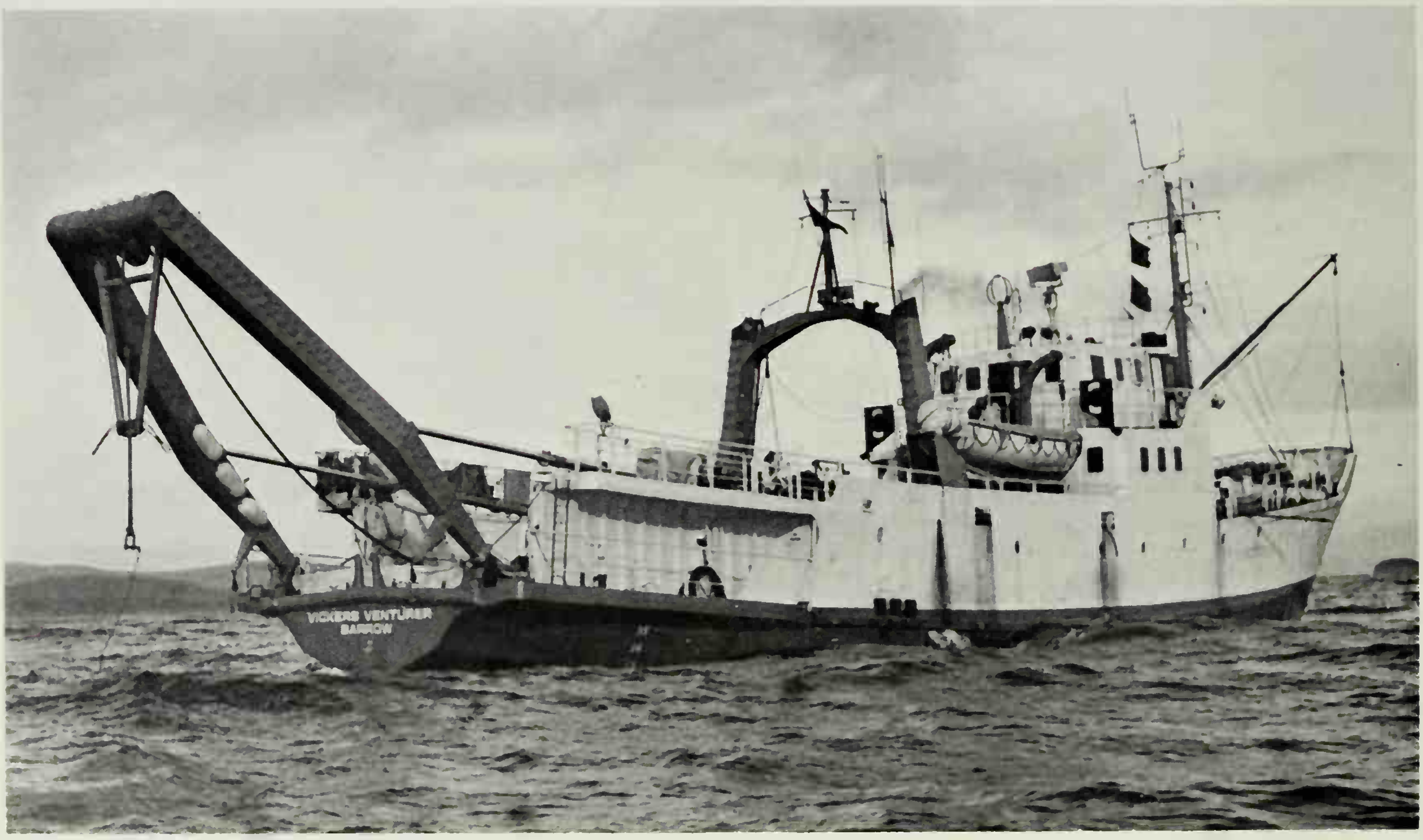
Positioning and servicing sonar beacons and other instrumentation

Acting as sonar target or sound emitter

Underwater maintenance and repair

Power source for tools or divers

Marine survey and sampling



Submersibles

for underwater naval work

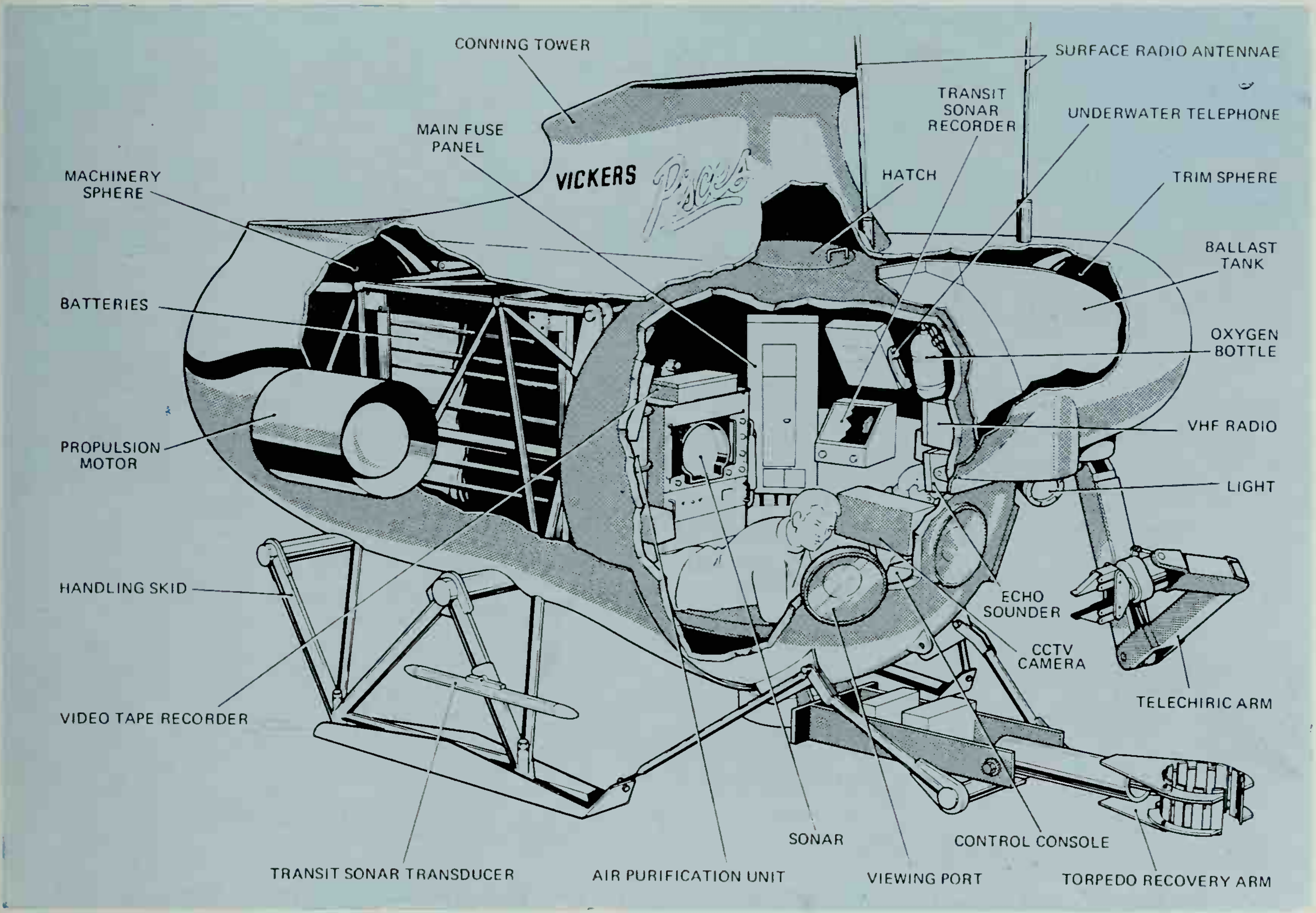
Vickers Pisces submersibles

Vickers-Pisces is a two-man work submersible with a depth capability of 1000 metres.

The craft is equipped with sonar, closed-circuit television, search and navigation equipment, and manipulators. Vickers-Pisces is normally operated from a surface support ship, the oceanographic research vessel *Vickers Venturer,* which carries a submersible location system SPATE (Submersible Position and Tracking Equipment).

One of Vickers-Pisces' main tasks to date has been torpedo search and recovery, and several weapons have been recovered from various depths down to 730 m (2400 ft). Other naval applications include location of sunken objects, assistance with salvage, hydrography, and laying and recovery of instruments.

The submersible can be operated in poor weather and seas up to sea state 4, using a specially developed handling gear fitted to the stern of *Vickers Venturer*. If necessary, Vickers-Pisces can be air-freighted to site and operated from other ships or shore installations.


CONNING TOWER
SURFACE RADIO ANTENNAE
TRANSIT SONAR RECORDER
UNDERWATER TELEPHONE
MAIN FUSE PANEL
VICKERS
Pisces
MACHINERY SPHERE
HATCH
TRIM SPHERE
BALLAST TANK
BATTERIES
OXYGEN BOTTLE
VHF RADIO
LIGHT
PROPULSION MOTOR
HANDLING SKID
ECHO SOUNDER
CCTV CAMERA
TELECHIRIC ARM
VIDEO TAPE RECORDER
SONAR
CONTROL CONSOLE
TRANSIT SONAR TRANSDUCER
AIR PURIFICATION UNIT
VIEWING PORT
TORPEDO RECOVERY ARM

Specification

Displacement: 11 300 kg (25 000 lb)
Length: 5·9 m (19 ft 4in)
Breadth: 3·0 m (9 ft 10 in)
Draft: 2·3 m (7 ft 6 in)
Overall height: 3·1 m (10 ft 4 in)
Maximum diving depth: 1000 m (3000 ft)

Payload
Personnel: 180 kg (400 lb)
Extra instrumentation: 225 kg (500 lb)
Additional oil ballast payload: 270 kg (600 lb)

Additional Continental Shelf lift capability using air system: 450 kg (1000 lb)
Total: 1130 kg (2500 lb)

Power source: 40 kWh, lead acid oil-filled battery
Propulsion motors: 2 × 3 hp
Endurance: 4 hours at 2 knots; 15 hours at ½ knot; 72 hours life support
Illumination: 2 × 100 W, QI lamps
Certification: American Bureau of Shipping
Manipulators: Torpedo grabs, 324 mm and 533 mm (12¾ in and 21 in) claws
General-purpose PHA manipulator

VICKERS SHIPBUILDING GROUP
Barrow Shipbuilding Works
PO Box 6, Barrow-in-Furness, Lancashire, England
Telephone: Barrow-in-Furness 20351 Cables: Vicarmsea Barrow-in-Furness
Telex: 6571

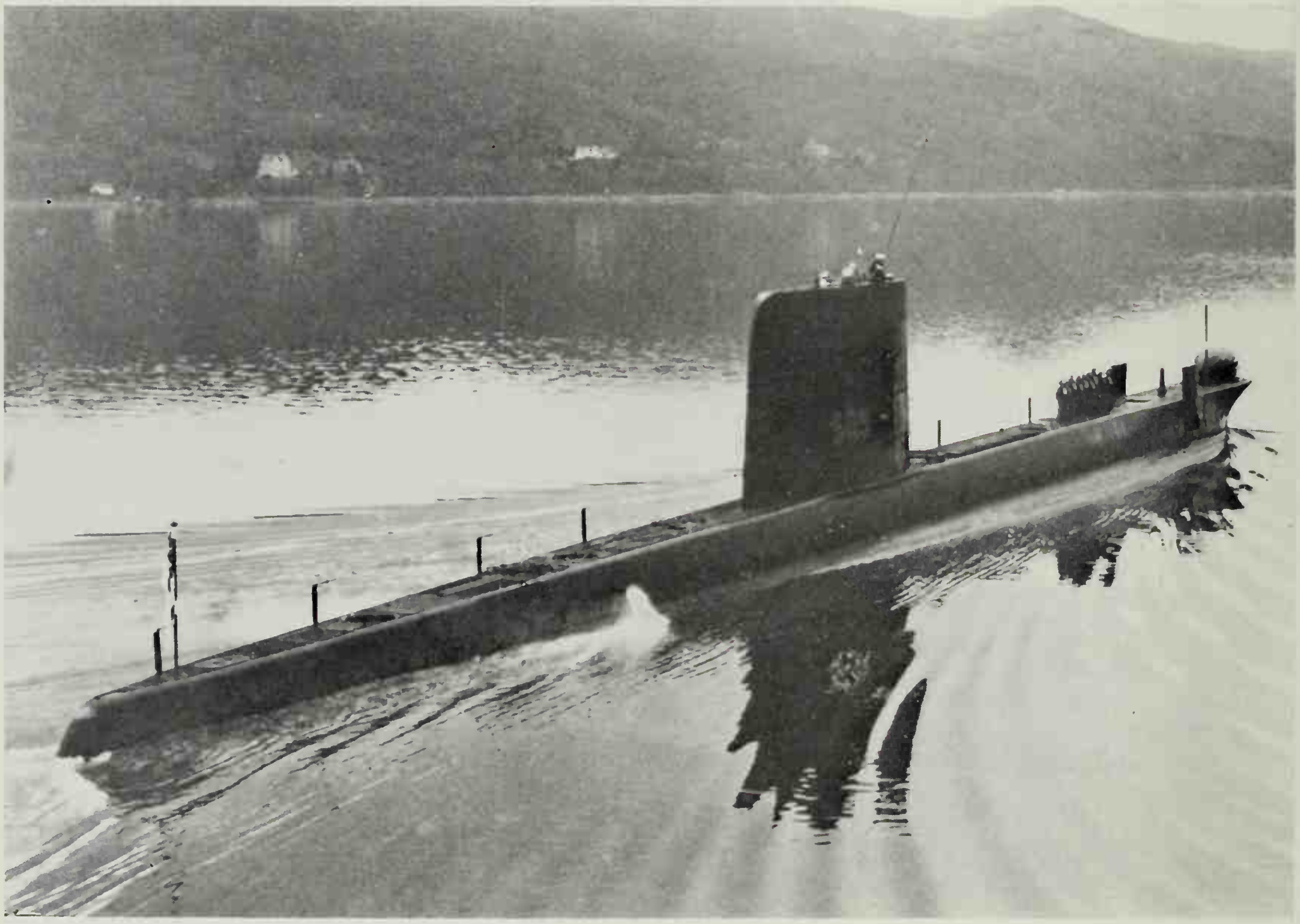
Oberon

diesel-electric patrol submarine

The Oberon is one of the most successful and advanced diesel-electric patrol submarines in the world. Together with the Porpoise class, from which it evolved, the 'O' Class is the mainstay of the Royal Navy's patrol submarine fleet and is in service with, or on order for, four other navies.

Particularly suited to anti-submarine and surveillance operations off enemy bases, the Oberon is fitted with several types of sonar device. The submarine is probably the quietest type in service and has proved highly successful in patrol duties

The design has been continually developed by the British Ministry of Defence and proved during 12 years of service. The Oberon and its ship systems are highly reliable and no serious accidents have occurred in over 30 000 days running at sea. Simplicity of operation and maintenance contribute to this safety record, as well as ensuring that operational availability remains high and in-service support is kept to a minimum.



Nearly thirty 'O' and 'P' Class submarines have entered service since Vickers built the first of class in 1958

Specification

Dimensions
Length overall: 90 m (295 ft 3 in)
Maximum breadth, external: 8·08 m (26 ft 6 in)
Inside hull dia: 5·41 m (17 ft 9 in)
Height to top of bridge fin: 13·08 m (42 ft 11 in)
Submerged displacement: 2418 tons

Main machinery
Diesel-electric propulsion, main generating diesel engines: two 16 Hz ASR-1 diesel engines each developing 1840 bhp max

Performance
Speed: over 16 knots submerged, over 14 knots surfaced
Range: over 22 500 km (14 000 miles)
Diving depth: greater than 150 m (500 ft)

Complement
Seven officers and 55 men

Weapon systems
Torpedoes: 6 tubes forward; 2 tubes aft
Torpedo control system: TCSS 7/9
Passive/active sonar and intercept sonar
Echo sounders, bathythermographs, etc

VICKERS SHIPBUILDING GROUP
Barrow Shipbuilding Works
PO Box 6, Barrow-in-Furness, Lancashire, England
Telephone: Barrow-in-Furness 20351 Cables: Vicarmsea Barrow-in-Furness
Telex: 6571

Vickers

Submarine weapons

Missile systems, fire-control systems and torpedoes

Several new weapons systems are being developed by Vickers to meet the needs of navies for inexpensive and easily fitted armaments to fulfil specific tasks. These weapons systems are being designed initially to exploit the potential of the Oberon Class submarine, but can also be adapted to suit other types of submarines. The systems can be fitted independently, or together to form an integrated weapons fit.

Submarine-Launched Air-Missile System (SLAM)

SLAM is designed to give submarines a surface attack capability, enabling them to carry out more effectively patrol and policing roles. The system carries six Short Brothers & Harland Blowpipe missiles in a launcher housed in the submarine fin.

SLAM is currently undergoing prototype trials and development by Vickers, and should be ready for demonstration at sea in 1971.

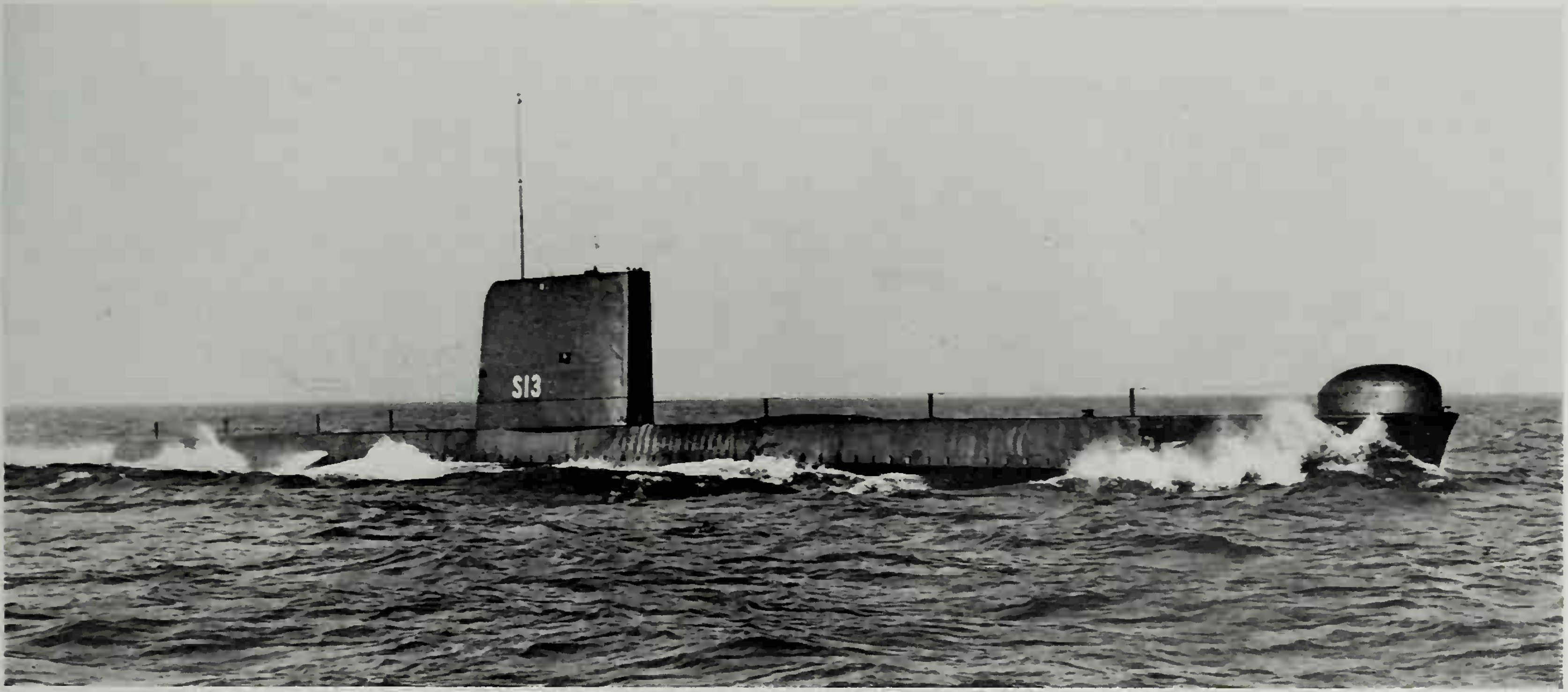
Tactical Information Organisation System (TIOS)

TIOS is an integrated fire-control system, based largely on existing hardware. It is designed to provide reliable torpedo control tactical situation display, and analysis of target bearing information at a low overall cost. Later versions of TIOS will include missile control capability, such as SLAM, and navigation aids.

The system, which is being developed by Vickers in conjunction with Ferranti and Gresham Lion Electronics, should be ready for demonstration at sea during 1971. TIOS is compatible with other systems on the Oberon submarines, and can be retrofitted.

Improved Mk 20 torpedo

To meet the need for an inexpensive torpedo compatible with modern control systems and available to overseas navies, Vickers has designed a cable-set modification for the Mk 20 torpedo. The Mk 20 is an anti-submarine torpedo of proven reliability, and the modified version will provide a very cost-effective alternative to existing torpedoes.



Successive Oberons incorporate many design improvements. The ships on order for Brazil and Chile will be among the most advanced yet produced

VICKERS SHIPBUILDING GROUP
Barrow Shipbuilding Works
PO Box 6, Barrow-in-Furness, Lancashire, England
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Telex: 6571

Vickers

Underwater weapons

and tracking ranges

Torpedoes

The company is the pre-eminent underwater weapon systems development organisation in the UK. Its capability stems from an unbroken record of 25 years' collaboration with the British Government in the development of guidance systems for acoustic homing torpedoes. The homing system electronic packages for every British torpedo in service or under development have been designed and produced by this company.

The company has been awarded a large contract by the British Admiralty Underwater Weapons Establishment for the completion of the development of an entire submarine torpedo and associated equipment—the first time in Britain that such a wide-ranging responsibility has been placed with industry. Forward-looking studies of potential successors to current designs are also in progress. The company has also been appointed the main contractor for the study of a new British lightweight torpedo for air-launching.

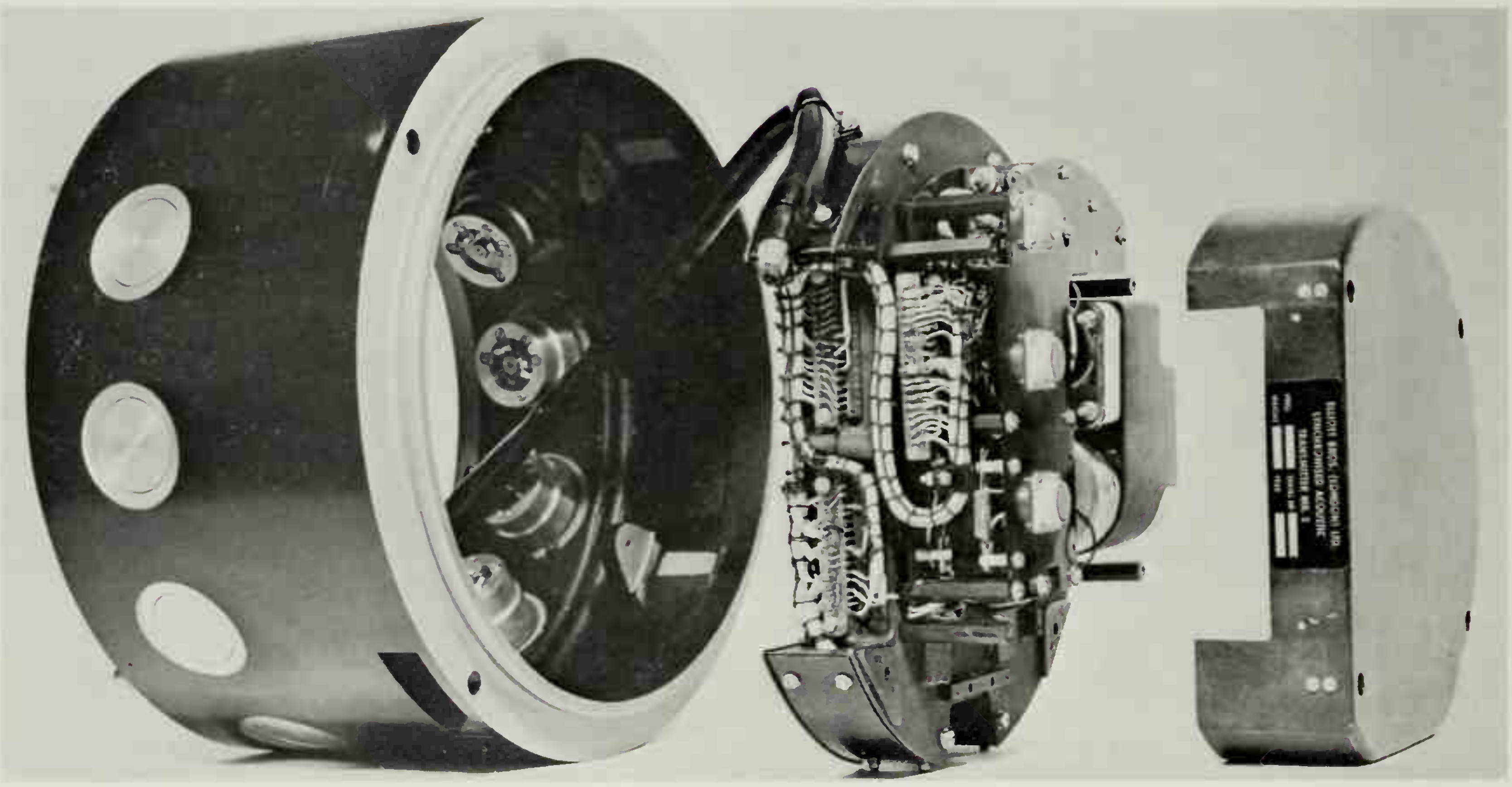
Underwater tracking ranges

Three types of tracking range are produced by Marconi Space and Defence Systems Limited. They are:

1. Sea-going 3D underwater tracking range, which can simultaneously track three separate targets and plot trajectories in real time to an accuracy of a few yards. Suitable for applications which require shallow and deep-water operation of the tracking range.
2. Portable underwater tracking range (target-centred 3D tracker), designed for fleet use in submarines, which provides a numeric 3D record of torpedoes fired by or against a submarine. Long-range tracking with high-definition mode in final attack phase.
3. Fixed tracking range, which can be used as a short-range, shallow-water, high-definition system or a long-range deep-water multi-target system. Signals from sea bed or surface buoyed arrays are transmitted to a shore installation via cable or radio data links.

All these tracking systems require 'active' targets. A standard range of synchronised acoustic transmitters, from 12·75 in to 21 in diameter have been developed for this purpose. These contain low-drift digital timing sources with a stability of better than 5 parts in 100 million. They are fitted into the target hull and do not materially affect the dynamic characteristics of the target. They can also be supplied as part of a more comprehensive practice head to replace the warhead.

For simple underwater location, the company markets an acoustic transmitter which can operate continuously for three weeks, at depths up to 365 m (1200 ft). It can be used with existing sonar receivers, although a portable directional receiver is available.



The torpedo installation consists of a synchronised acoustic transmitter (SAT) fitted in the weapon practice head. In addition, a small unit used for synchronising purposes is required in the submarine or aircraft firing the weapon. The SAT fitted in the torpedo is one of a standard range of devices developed for this purpose, fully compatible with both British and United States tracking installations and available for 12¾in or 21in torpedoes, and in most cases suitable for environmental conditions appropriate to airborne or rocket launch

A GEC-Marconi Electronics Company

MARCONI SPACE AND DEFENCE SYSTEMS LTD

Headquarters

The Grove, Warren Lane, Stanmore, Middlesex, England

Telephone: 01-954 2311 Cables: Electronics Stanmore Telex: 22616

Depth presetting system

for torpedoes

AUW presetter Mk 1

The purpose of the presetter is to pre-select (or preset) the initial search depth (ISD) and floor depth (FD) settings of torpedoes. There are six possible settings of ISD and five settings of FD.

The presetter forms one half of an ac Wheatstone bridge (the other half being within the weapon). Selection of a new depth setting unbalances the bridge, the detector senses the unbalance and operates a relay which delivers, via the 'set' switch, power to a Ledex stepping switch in the torpedo. Operation of the 'set' switch causes the Ledex switch to step round until the new depth is selected and the bridge re-balanced.

The above circuit is duplicated for the two depth settings needed. The ac supply to the bridges is produced by an astable multivibrator operating at about 1 kHz.

The detectors are transistorised and transformer-coupled to the bridges.

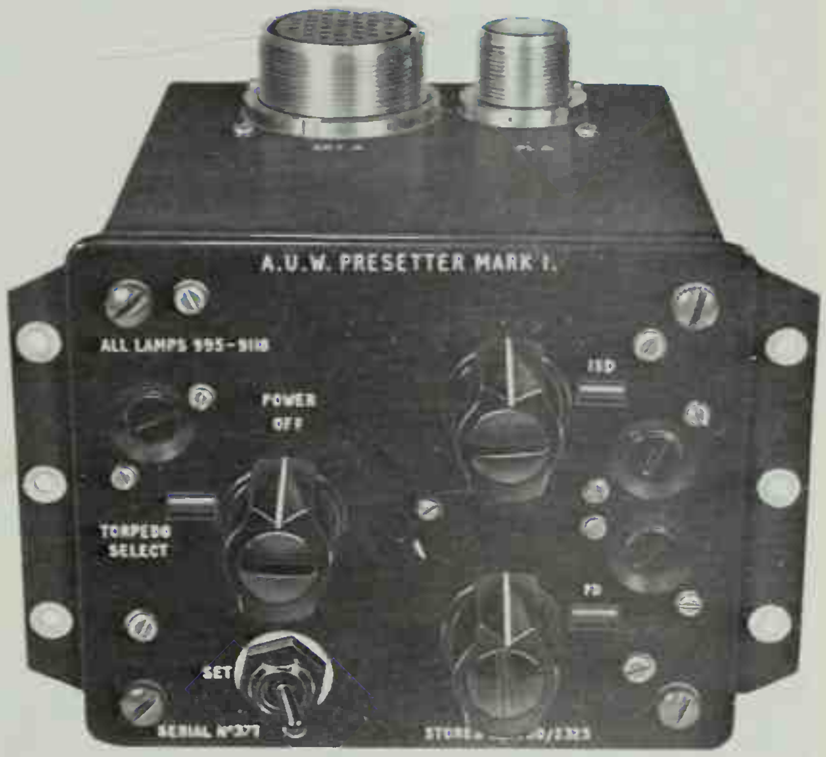
Despite the compact size and light weight of all units, the system can handle several torpedoes.

Correct operation is indicated by lamps and the selected switch positions are also illuminated to give immediate and constant visual indication of all settings. The system is arranged to fail safe. An interlock is incorporated to prevent operator error.

Locations for connectors are provided at the top, bottom and rear of the presetter to enable it to be mounted in any convenient situation. The equipment is equally suitable for use on ships and on aircraft.

Although designed for operation at 28 V dc nominal, the presetter has a wide voltage tolerance and operates correctly from 22 V to 30 V dc.

The system is suitable for use with Mod 0 and Mod 1, Mk 44 torpedoes.



The Plessey AUW presetter Mk 1 for presetting the running depth of torpedoes

Specification

Depth setting range: Range of depth settings available
Operational temperature range: –25 °C to –70 °C
Operational ceiling: 9100 m (30 000 ft)
Environmental conditions: Tested to the following specifications:
  Acceleration: Av.P.24, Chapter 104, Category 5 of table 4
  Vibration: Av.P.24, Chapter 105, for rotorcraft, Fig. 5
  Crash landing: Av.P.24, Chapter 104, Clause 4, Applied acceleration 25g
  Climatic: D.T.D. 1085B
  Drop tests: K.114, Part 6.1 and K114, Part 5.2
  Salt corrosion: K.114, Part 5.14
  Contamination: To the method of DEF 133
Dimensions: 178 × 127 × 152 mm (7 × 5 × 6 in)
Weight: 2·2 kg (4¾ lb)
Power supply: Nominal 28 V dc negative earth. Voltage limits 22 V to 30 V dc. The unit will not be damaged by short-term transients not exceeding 60 V (positive) or 100 V (negative)
Current consumption: Mean current 0·5 A. Peak current 5 A (approx.)

THE PLESSEY COMPANY LIMITED
Electronics Group
Ilford, Essex, England
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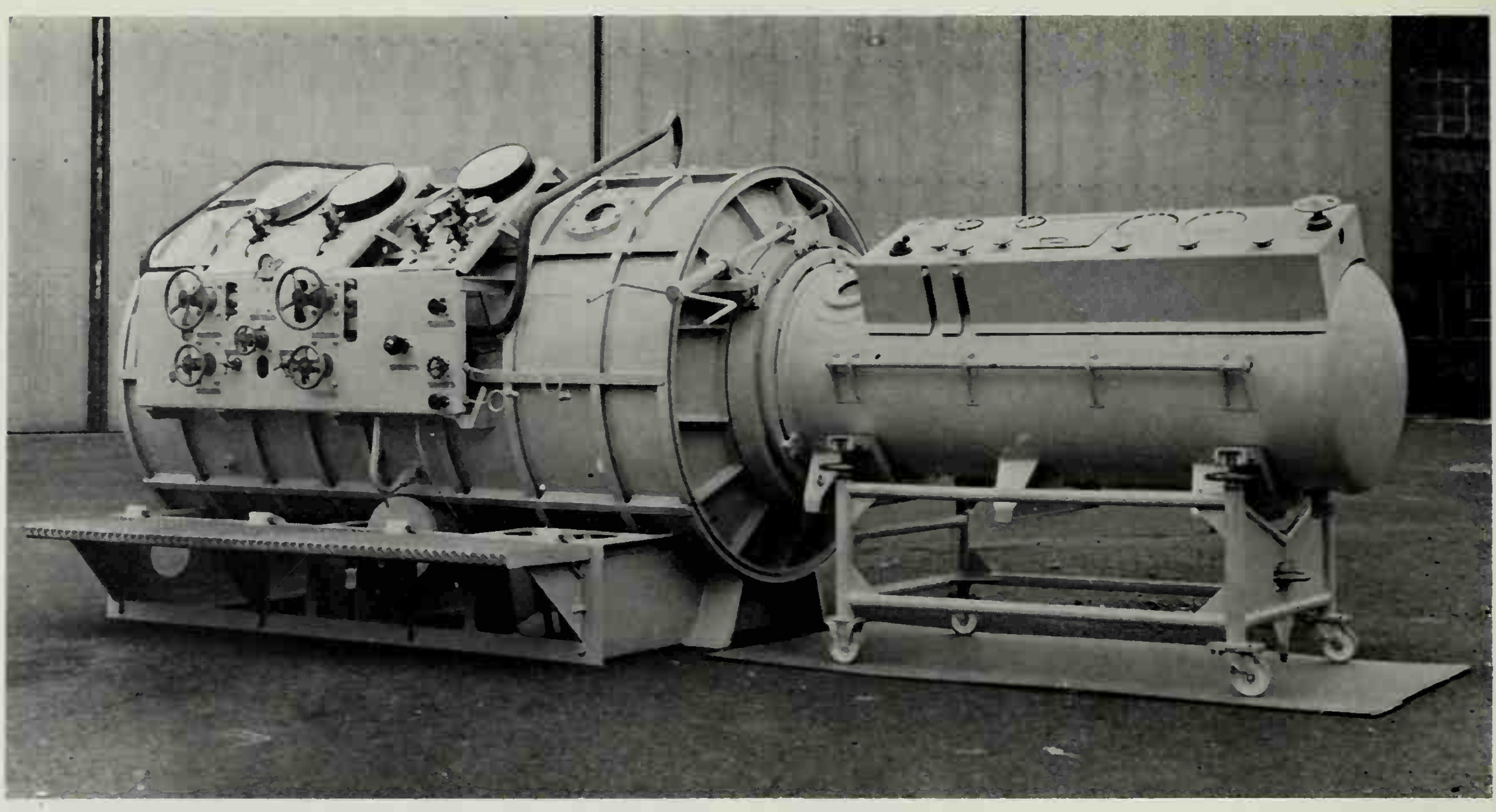
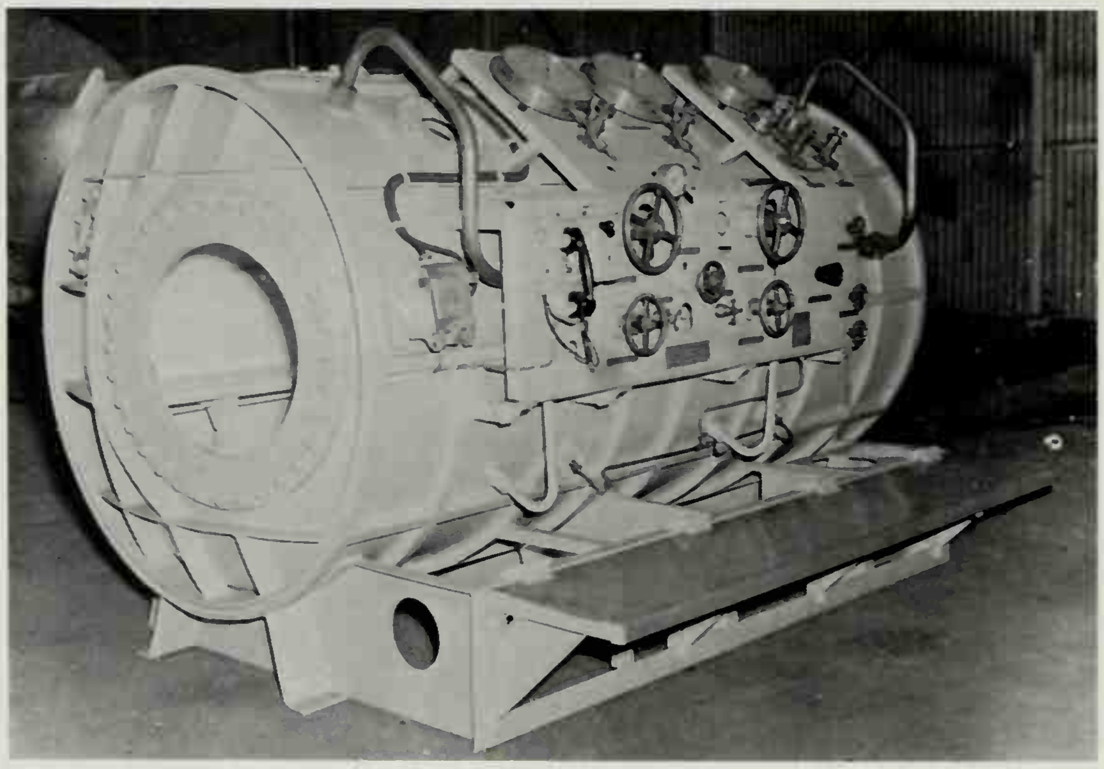
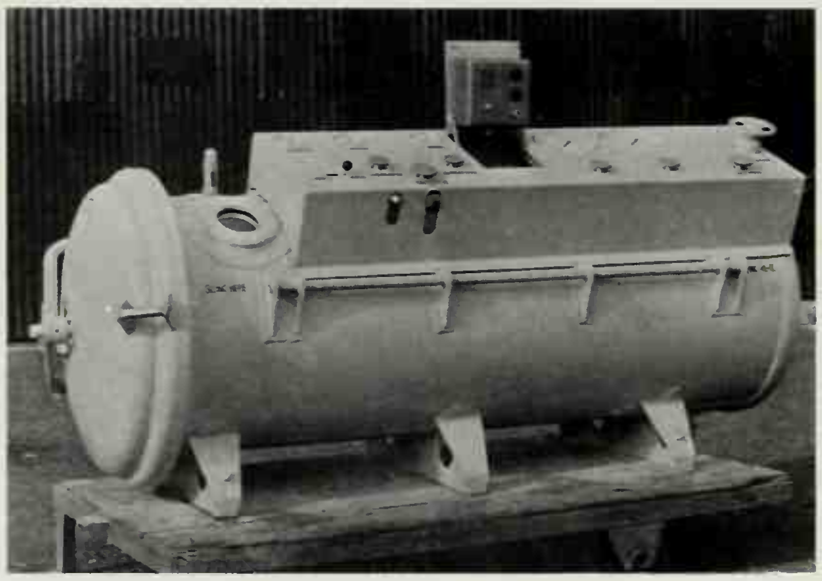
1969



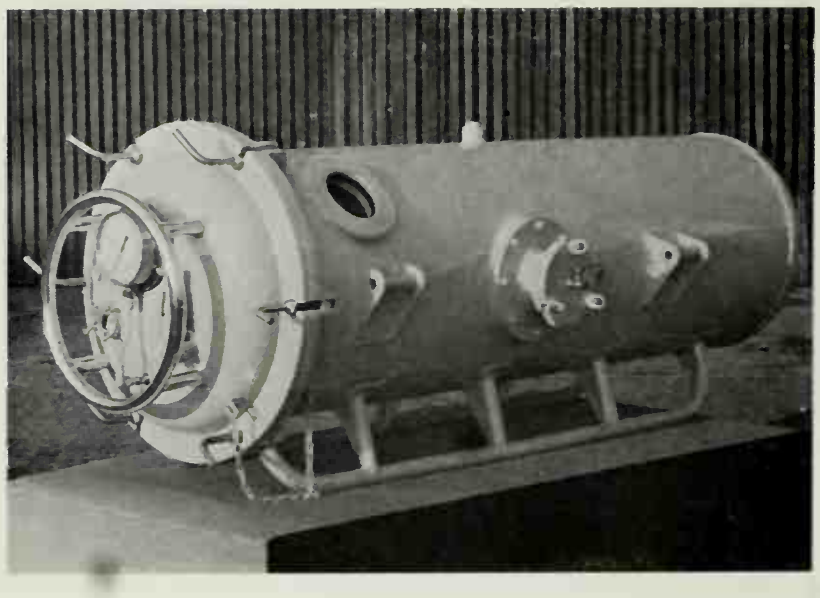
The transfer-under-pressure system, when a Type 1 and Type 4 chamber are interconnected, enables a patient being treated in the smaller chamber to be transferred to the larger chamber where medical assistance can be given in a more spacious environment. On completion the two chambers can be separated and the smaller released for immediate further use



The Type 1 chamber is extensively used where teams of divers are operating. Seven men can be held in the main compartment and a further three men in the air lock. The chamber incorporates a telephone system and individual oxygen connections



The Type 4 chamber is readily transportable by land, sea or air. It is both compact and of advanced design and capable of supporting deep-water diving operations



The low weight and compact dimensions of the Type 5 chamber allow maximum ease in handling. It has been designed for diving work in relatively shallow waters

Compression chambers

for divers

The role played by the professional diver in underwater operations, both military and civil, has become increasingly important in recent years both in defence and in projects involving marine surveys, repairs and demolitions. The proficient amateur diver, participating in a novel but increasingly popular sport, is extending his dives to greater, but more hazardous depths.

Diving operations frequently entail working at considerable depths, and the staging procedure of a slow ascent to the surface which is necessary to allow the diver to become adjusted gradually to pressure changes without suffering decompression sickness, has imposed severe limitations on the time which can be allocated to the actual work beneath the surface.

The use of a chamber permits a more rapid ascent followed by a surface decompression completed relatively free of the hazards associated with the staging procedure previously employed. This has the benefit of considerably increasing the potential of the diver as an underwater technician in that he can remain at work beneath the surface for a longer proportion of his diving time with the confidence that his normal penalty of stoppage time can be completed in the relative comfort of a chamber. Furthermore the chamber provides a facility for the therapeutic treatment should a diver develop a 'bend' after surfacing and enables training and pressure-conditioning programmes to be readily carried out.

Intensive development and rigorous testing have resulted in the establishment of a range of compression chambers backed by auxiliary equipment such as air cylinders and pump.

The models listed below are manufactured in corrosion-resistant aluminium to the highest standards and cover a wide range of operational conditions.

Type 1—Ten-man two-compartment compression chamber

This model was designed to meet the extensive requirements for the recompression and subsequent decompresssing of teams of divers, whether on seaborne or shore-based operations or in training, and for therapeutic treatment and research.

The main compartment is entered through a single air lock to which a quick-action pressuretight door is fitted at each end, permitting one man to enter at a time. Seven men can be comfortably held in the main compartment with ample space for a further three men in the air lock. Each man has an individual oxygen connection and a telephone system is incorporated in each compartment. Medical supplies and food can be passed by means of a small hand air lock.

The control panel, fitted with the necessary supply vent and bleeding valves, pressure gauges and telephone, is shaped around the shell of the chamber and bracketed to it.

Length overall: 3·47m (11ft 4½in)
Width overall: 2·01m (6ft 7in)
Height overall: 1·91m (6ft 3¼in)
Inside diameter: 1·54m (5ft 0¾in)
Length, main chamber: 1·80m (5ft 11in)
Length, air lock: 1·07m (3ft 6in)
Diameter, access door: 0·60m (1ft 11¾in)
Weight: 1565kg (3450lb)
Volume (approx): 5·4m^3 (190ft^3)
Hydraulic test pressure: 10·5kg/cm^2 (150lb/in^2)
Air rest pressure:7·0kg/cm^2 (100lb/in^2)
Maximum permissible drop in 24 hours: 10%
Normal working pressure: 7·0kg/cm^2 (100lb/in^2)
Oxygen circuit tested to: 316·4kg/cm^2 (4500lb/in^2)

Type 5—One-man compression chamber

When diving operations are to be confined to relatively shallow waters the demands on a compression chamber are less exacting.

The Type 5 has been developed as a lightweight unit to support operations where the advanced features of the Type 4 are not required. The working pressure capability is lower and the depth pressure gauge, vent valve, relief valve and through connection for oxygen breathing apparatus are mounted on the door inside the handling ring. An air lock can also be fitted if required.

The low weight of this chamber permits maximum ease in handling.

Length overall: 2·24m (7ft 4in)
ength internal: 2·13m (7ft)
Diameter internal: 0·56m (1ft 10in)
Height: 0·79m (2ft 7in)
Width with hand air lock: 0·81m (2ft 8in)
Hydraulic test pressure: 8·4kg/cm^2 (120lb/in^2)
Working pressure maximum: 5·6kg/cm^2 (80lb/in^2)
Weight: 113kg (250lb)
Extra: glassfibre stretcher with vinyl-covered mattress: 13kg (28lb)
Hand air lock: 11·4cm (4½in) dia; 13cm (5½in) long; 5kg (12lb)

Type 4—One-man compression chamber

Many diving operations are carried out in remote areas where permanent recompression equipment is not available and where the transport of such equipment would not be practicable.

This model meets the demand for a compact chamber readily transportable by land, air or sea for locations where surface equipment is required both to support diving operations and as a safety measure to meet decompression sickness emergencies.

A control panel is mounted on the side of the chamber on which are grouped all gauges and controls along with a retractable speaker/microphone unit to maintain communication with the diver during the compression cycle.

This chamber is an advanced unit offering the safety, quality and operational efficiency necessary to military diving and to specialised deep-water engineering problems.

Length overall, door closed: 2·44m (8ft)
Length overall, door open: 3·15m (10ft 4in)
Height speaker unit closed: 1·14m (3ft 9in)
Height speaker unit open: 1·37m (4ft 6in)
Width door closed: 1·09m (3ft 7in)
Width door swung fully open: 2·11m (6ft 11in)
Internal diameter: 0·76m (2ft 6in)
Internal length: 2·13m (7ft)
Cubic capacity: 0·88m^3 (31ft^3)
Weight: 263kg (580lb)
Hydraulic test pressure: 10·5kg/cm^2 (150lb/in^2)
Working pressure, max: 7.0kg/cm^2 (100lb/in^2)

Type 6—One-man compression chamber

This model is similar in every respect to the Type 4 but is equipped with specially adapted feet to facilitate transport by helicopter.

Transfer-under-pressure system

The Type 1 two-compartment chamber and Types 4 and 6 one-man chambers can be modified to provide an interconnection facility with both chambers at pressure, thereby permitting a transfer under pressure from the smaller chamber to the larger.

This enables patients, forced by circumstances to commence therapeutic treatment in the relatively confined space of a one-man chamber, to complete the decompression schedule in a more spacious environment where medical assistance can be given.

The T-U-P two-compartment chamber embodies an access door at the end opposite to the air-lock entry, an external sealing ring and a steel clamping ring with intermittent dogs, actuated by means of a handwheel. The weight is 1746kg (3850lb).

The T-U-P one-man chamber has an adaptor ring and a door with removable external hinge, increasing the weight to 338kg (745lb). The chamber is supported on an aligning trolley, engaged with the larger chamber and the pressure in both chambers and in the intervening space is equalised.

The large chamber door is then opened, a substitute hinge coupled to the one-man chamber door and, on opening it, the stretcher and patient withdrawn from the smaller chamber. If the patient's condition permits he can be seated in the larger chamber and, after reversing the above procedure, the two chambers can be separated and the smaller released for further use.

CAMMELL LAIRD (ANGLESEY) LIMITED
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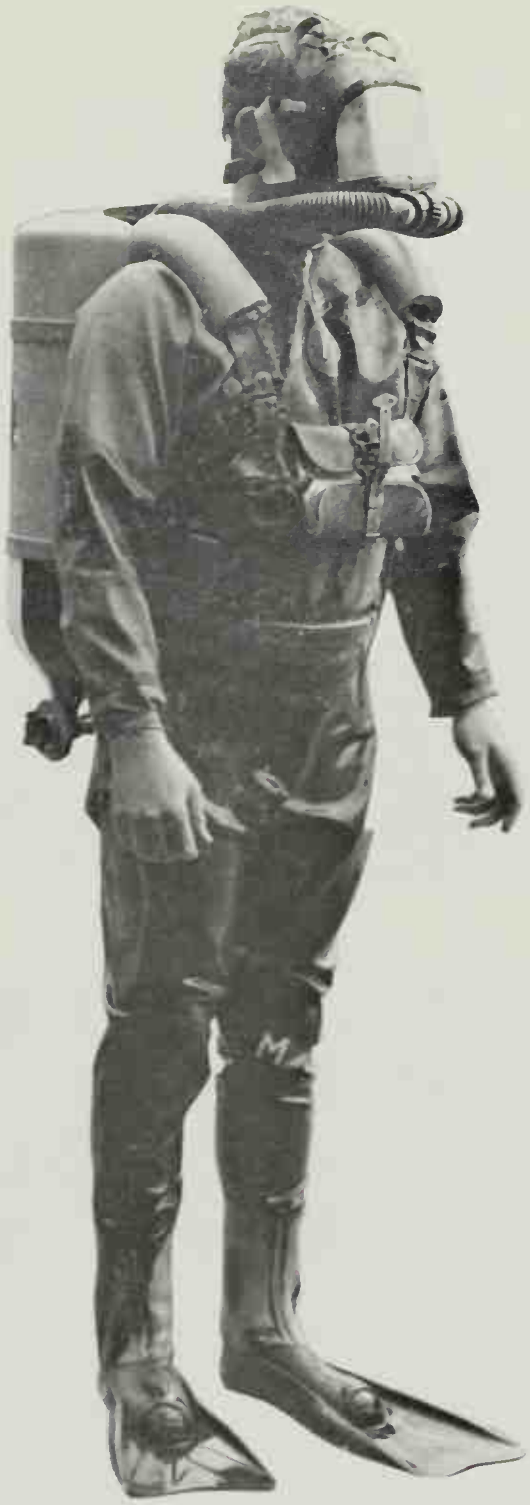


Swimmer's air breathing apparatus (SABA)

The SABA is a twin-cylinder open-circuit Admiralty breathing set manufactured in corrosion-resistant non-magnetic light alloy and stainless steel. The cylinder capacity is 2800 litres free gas at a maximum working pressure of 170 kgf/cm^2 (2400 lbf/in^2).

The apparatus (shown at the left) is highly efficient for harbour maintenance purposes and for searching the underwater section of ships. It can be used in comfort and safety by clearance divers down to 51 m (180 ft) depth.

The complete SABA consists of cradle and weight boxes, front weight pocket and belt, main and reserve air cylinders with associated valves, and a single-stage high flow-reducing valve, feeding the rear-mounted demand valve, face mask and breathing tube assembly.

Surface demand diving equipment (SDDE)

The SDDE is a light alloy mobile breathing set suitable for divers down to a maximum of 51 m (180 ft).

The diver's equipment, which is worn with the underwater swimming dress and associated items, comprises a standard damage control breathing apparatus modified to carry divers weights in the front pocket and fittings for flexible supply hoses from the surface. At the surface the supply hose is connected to a surface control panel supplied with high-pressure air from the ship's main or portable air compressor (or from a storage cylinder). The panel contains arrangements for controlling air pressure to the diver according to his depth and can support two divers for normal working; in an emergency it can accommodate a third diver.

The SDDE has twin cylinders, each charged to 210 kgf/cm^2 (3000 lbf/in^2) air pressure, which automatically supply the diver should the surface supply fail. The breathing apparatus is of the open-circuit type, the used air being exhausted into the surrounding water.

The complete SDDE equipment consists of cradle and supporting frame, front weight pocket, belt and swivel hose connection, main and reserve cylinders with associated valves, and a single-stage high-flow-reducing valve feeding the demand valve, face mask and breathing tube assembly.

Damage control breathing apparatus (DCBA)

The DCBA is a lightweight self-contained compressed-air breathing apparatus for use in irrespirable atmospheres, flooded compartments and fire fighting. It is simple to operate and can be used above or below water without modification or adjustment. Provision is made to supply air to a second face mask on an extension harness, which can be coupled to the set through a 1·8 m (6 ft) hose when rescuing a casualty, to provide a supply of air at the earliest opportunity. The apparatus consists of two steel containers having a working pressure of 254 kgf/cm^2 (3600 lbf/in^2) and a free gas capacity of 1200 litres; at normal air pressure the endurance is approximately 40 minutes.

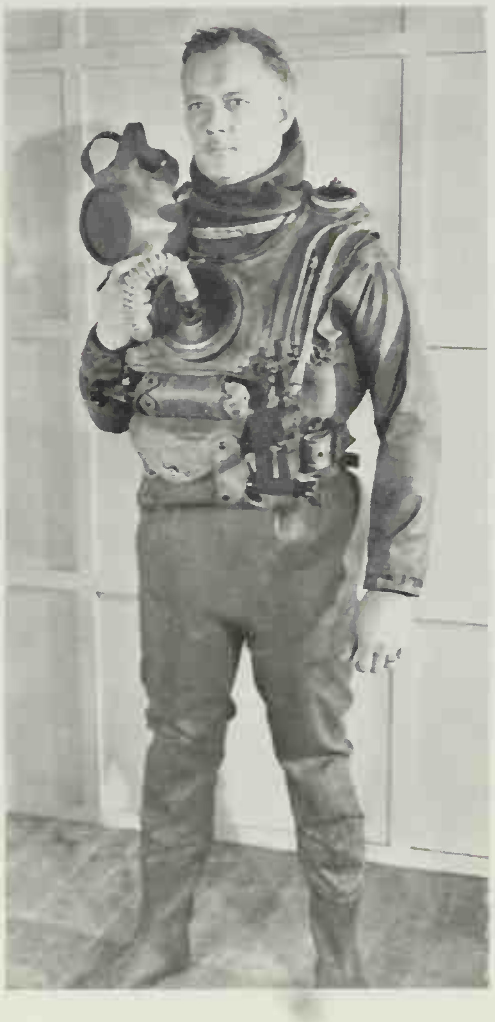
The control system consists of a normal single-stage reducing valve feeding air to the demand valve. The face mask is coupled to the demand valve by flexible hoses. The set has an equaliser valve for guidance on air consumption: one cylinder feeds the system while the second is held in reserve for topping-up purposes.

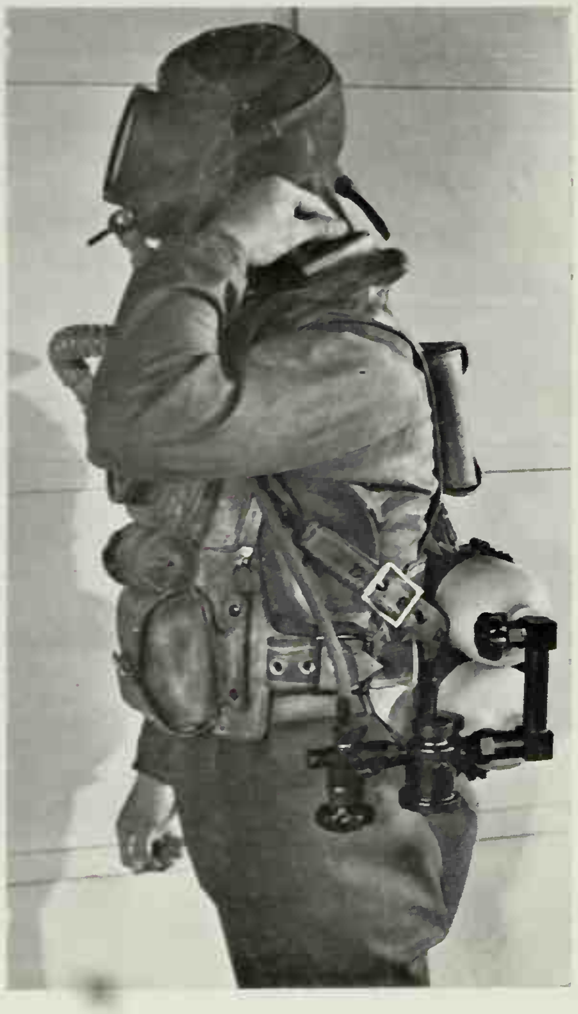
Clearance diving breathing apparatus (CDBA)

This apparatus (shown below) is a semi-closed-circuit re-breathing set in which the breathing bag contains a volume of oxygen-enriched mixture gas substantially equivalent to the surrounding media and of that in the user's lungs. The gas in the bag is under constant replenishment at an actual controlled flow unaffected by back pressure from an uncompensated reducing valve. All gas, including by-pass gas, is finely filtered. The equipment consists of an integral harness and breathing bag, relief valve, twin light alloy gas cylinders, a canister holding 0·9 kg (2 lb) charge of soda-lime granules readily rechargeable, a wide-vision face mask complete with mouthpiece cock, a corrugated breathing tube and an emergency gas cylinder.

The trim is achieved by lead weights loaded into a collapsible fabric container fixed to the rear harness. Weights are quickly releasable in all attitudes by manual operation of the quick-release device.

The Mk 2 version of CDBA is on trial with the British Ministry of Defence Diving Establishment at the Royal Navy; NATO approval can be expected when the trials are complete.





Breathing apparatus

High-pressure compressors and boosters

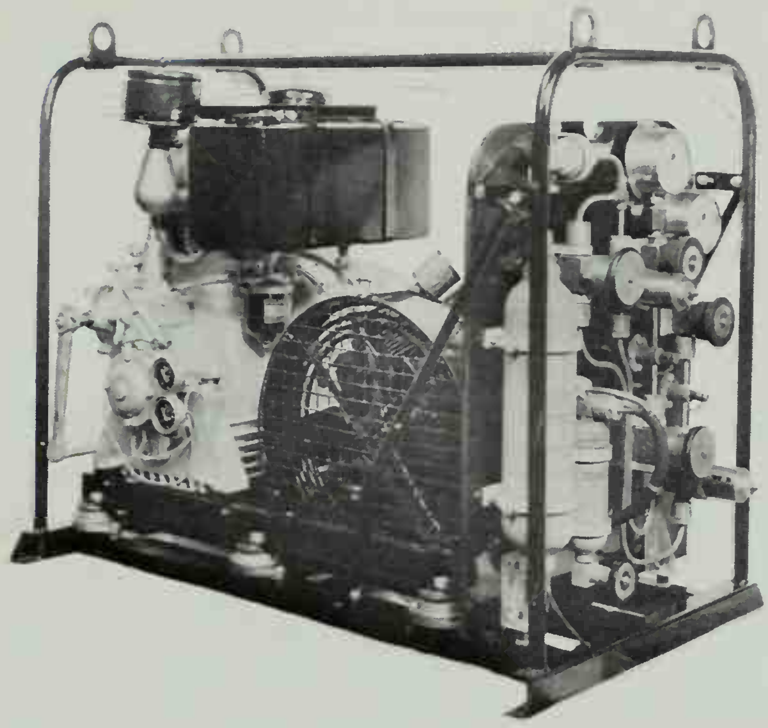
Diesel-driven compressor set

The set Type IC 112 is a standard product used throughout the Royal Navy for charging underwater breathing sets and damage control apparatus. It is driven by an Enfield VS1 diesel engine which is mounted with the compressor on a sub-frame. Air is fed to a distribution panel equipped with cleaning and drying apparatus to ensure that clean, dry air is available.

The distribution panel can be supplied with several delivery pressures: 170 kgf/cm^2 (2400 lbf/in^2) for SABA, 210 kgf/cm^2 (3000 lbf/in^2) for SDDE and 254 kgf/cm^2 (3600 lbf/in^2) for DCBA.

Alternatively this equipment can be divided into two parts—namely an engine and compressor assembly on its own base and a distribution panel which can be a separate component with piping to the compressor.

A range of motor-driven machines are also built for the Royal Navy with a variety of panels suitable for charging breathing apparatus direct from a compressor or from a storage system charged by a compressor.

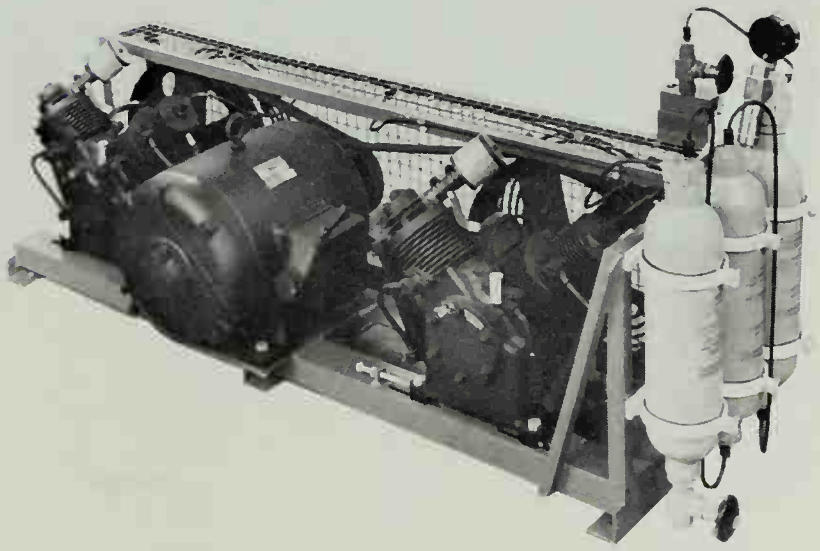


Twin compressor set

This new Dunlop IC 476 twin compressor set is designed to combine high output with minimal weight and size. Its high volumetric efficiency reduces the running cost per unit volume of output to an unprecedentedly low level.

Powered by a 400 V, three-phase, 50 Hz electric motor, it incorporates an oil and water trap and dehydrators set to customers' requirements together with filter and pressure gauge. The air delivered conforms to NATO, British Ministry of Defence and Home Office requirements for purity and dryness.

Both compressor and motor are mounted on a frame which is bolted down when static installation is required. The output is 280 litres (10 ft^3) per minute nominal. The weight of the unit is about 230 kg (500 lb).



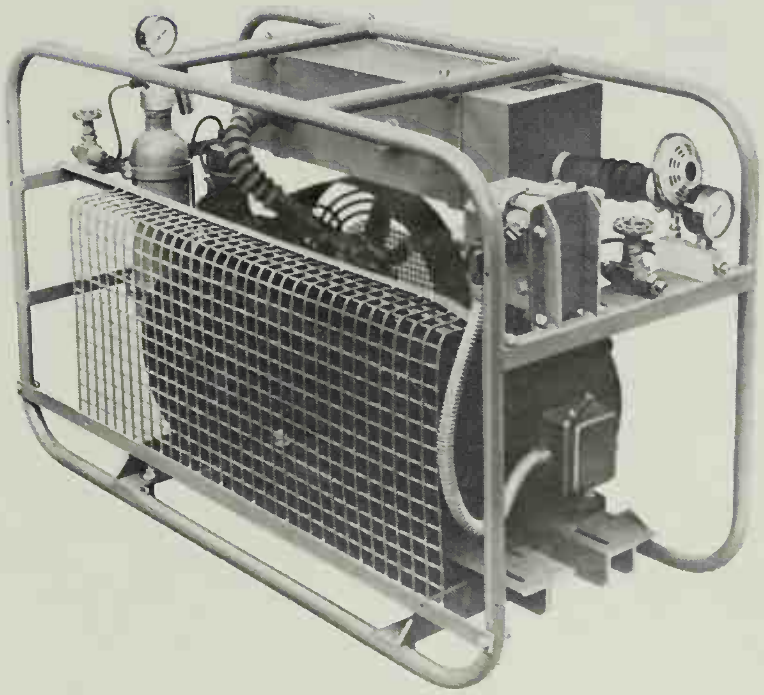
Nitrogen boost system

Nitrogen gas is normally obtained from suppliers at 130 kgf/cm^2 (1800 lbf/in^2). Boosting is therefore necessary to charge receivers, such as inert gas accumulators, to 280 kgf/cm^2 (4000 lbf/in^2).

Dunlop booster sets are designed to transfer the maximum amount of gas with minimum loss, by feeding the compressor via a demand valve. This valve allows full pressure to be drawn from the supply bottle into the compressor at the beginning of the compression cycle. Full output continues to be obtained until the pressure in the supply bottles falls to 3·5 kgf/cm^2 (50 lbf/in^2).

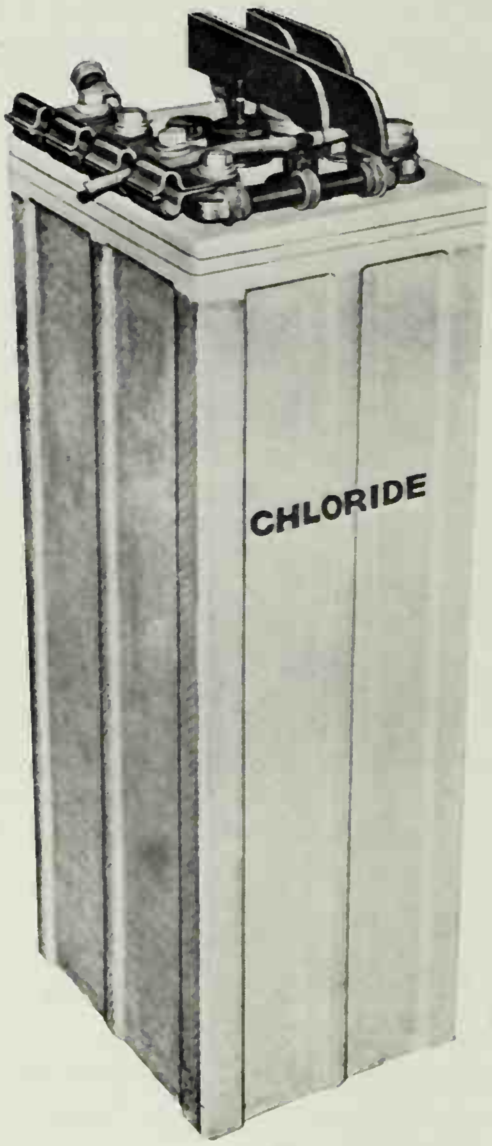
No gas is lost during the compression cycle because the crankcase of the compressor is sealed and the breathing or piston losses are piped back into the first-stage inlet. Wastage is thus practically nil.

Dunlop nitrogen boost sets are available powered by a 400/440 V, three-phase electric motor.



THE DUNLOP COMPANY LIMITED
New Products Division
Holbrook Lane, Coventry, CV6 4AA, England
Telephone: Coventry 88733 Cables: Sound Coventry Telex: 31677

HMS *Onyx*, an 'O' Class submarine



One of the submarine cells fitted in HMS *Onyx* for main propulsion

Main batteries

for submarine propulsion

Chloride, Exide and Kathanode lead-acid submarine main 'propulsion batteries have been supplied to the Royal Navy and many other navies since 1902. They are also used in all Royal Navy nuclear submarines.

Four battery types currently in service with navies throughout the world are: the 6560; the 7420 (NATO A); the 8100, which has an increased performance in the same volume as the 7420; and the 10500 (NATO B).

Design features

Submarine batteries manufactured by Electric Power Storage Limited have a number of important design features which, under normal conditions of submarine propulsion work, ensure a service life in the region of five years. These design features include:

(1) Plate groups specially designed for use in submarine main batteries, with double separation between the plates for durability, high performance and low open-circuit loss

(2) Lightweight glass fibre container and cover designed to withstand very severe shock test requirements

(3) Lead-plated copper intercell connectors for good electrical contact and mechanical strength

(4) Forced circulation of the electrolyte by compressed air to ensure mixing of the electrolyte, so reducing charging time and increasing efficiency

(5) Copper water-cooling plates are fitted to the terminals af each cell, to remove heat and to enable charging to be carried out without interruption.

Electrical performance

Type	Duration of discharge	Rate of discharge	Capacity in ampere-hours	Output per cell	Final volts per cell average	Mean volts per cell
	hours	A		Wh		
6560	1	4300	4300	7138	1·46	1·66
	3	1947	5840	10629	1·61	1·82
	5	1312	6560	12267	1·67	1·87
	10	739	7390	14115	1·73	1·91
7420	1	4870	4870	8080	1·46	1·66
	3	2200	6600	12010	1·61	1·82
	5	1484	7420	13870	1·67	1·87
	10	836	8360	15960	1·73	1·91
8100	1	5200	5200	8632	1·46	1·66
	3	2390	7170	13049	1·61	1·82
	5	1620	8100	15147	1·67	1·87
	10	920	9200	17572	1·72	1·91
10500	1	6560	6560	10750	1·46	1·64
	3	3060	9180	16520	1·61	1·80
	5	2100	10500	19530	1·67	1·86
	10	1187	11870	22670	1·73	1·91

Dimensions (nominal)

Type	Length of container	Width of container	Height over container and cover	Height over cell terminals
	mm	mm	mm	mm
6560	443	341	1026	1088 (with cooling plates)
7420	449	360	1081	1143 (,, ,, ,,)
8100	449	360	1081	1143 (,, ,, ,,)
10500	548	388	1210	1268 (without cooling plates)

Weights

The average weight of a single cell filled with electrolyte but excluding intercell connectors and cooling plates is not more than:

Type 6560	450 kg
Type 7420	501 kg
Type 8100	519 kg
Type 10500	753 kg

ELECTRIC POWER STORAGE LIMITED
Government Marketing Division
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A member of The Chloride Electrical Storage Group

Bathythermograph

Plessey-Sippican expendable type

The Plessey-Sippican XBT expendable bathythermograph permits accurate and continuous ocean temperature and ocean depth measurements to be made in any sea state, at ship's speeds of up to 30 knots, without slowing the ship or restricting its course in any way. It is a simple, accurate and dependable system, easy to operate and maintain, capable of providing a profile to a depth of 460m (1500ft) in less than 90sec.

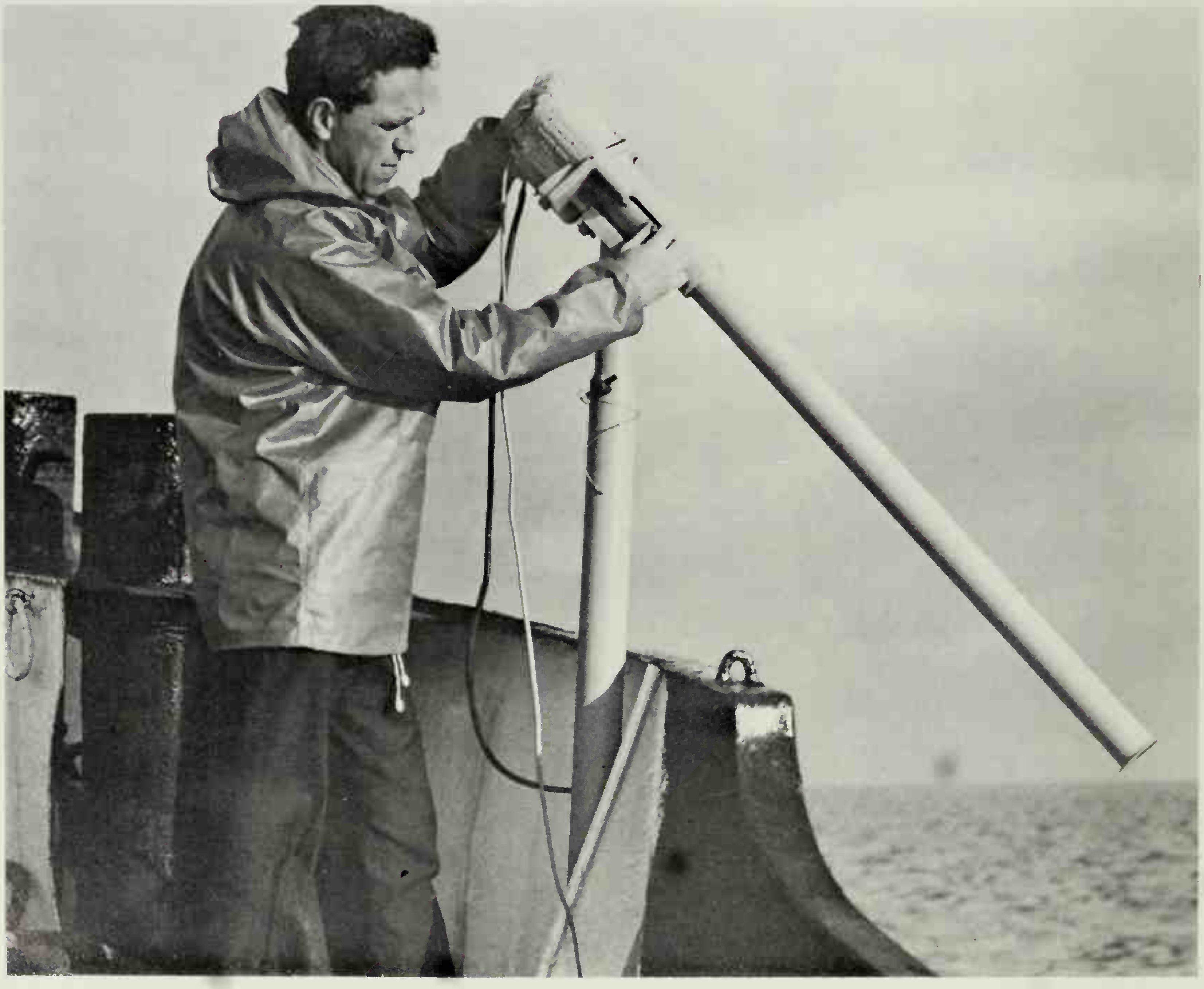
The basis of this system is a small ballistically shaped probe containing a thermistor connected to a spool of fine wire which is dropped from a launcher normally mounted at the stern of a ship. The wire of the probe is dereeled as the probe drops vertically through the water. The other end of the wire is wound on a second spool mounted within the probe canister. As the ship moves ahead this wire is also dereeled, allowing the probe to fall free, completely unaffected by the ship's motion or the state of the sea. The nose of the probe is weighted and the entire unit spin-stabilised to ensure descent from the launcher at the known rate.

Changes in resistance of the thermistor due to temperature changes of water are transmitted by the trailing wire to a recorder mounted on board ship.

Since the rate of descent of the probe is accurately known, depth can be read directly from the time scale of the recorder. After the probe passes 460m (1500ft), its wire is exhausted and it sinks to the ocean bottom. This continuous temperature-depth profile is traced on the recorder chart, giving far greater resolution and durability at less cost than the trace normally recorded on the smoked glass slide of the conventional bathythermograph. This system, already in use in many navies of the world, has similar applications in the commercial field, for example in the fishing industry and in oceanographic research.

Specification
Depth range: 460m (1500ft)
Depth accuracy: ±2%
Temperature range: −2°C to +35°C (28–96°F)
Temperature accuracy: ±0·2°C (±0·36°F)
Rated ship speed: up to 30 knots

Dimensions and weights
Recorder: 337 × 324 × 352mm (13¼ × 12¾ × 13⅞in)
Weight: 16·3kg (36lb)
Launcher
Breech and discharge tube: 1240mm (48in) long
Mounting stanchion: 1170mm (46in) long
Weight combined: 35kg (77lb)
Operating cost: the expendable probes cost about £stg10 each, depending on quantity ordered



Mine-hunting system

cost-effective, quick, reliable

The Marine Systems Division of Plessey is responsible for overseas sales of the outstandingly successful Royal Navy mine-hunting system. The Division's responsibilities cover all aspects of procurement, installation, preparation for acceptance and post-acceptance support of the complete system. It also includes, when necessary, consultation on all ship construction aspects of installation.

Cost-effective minehunting demands speed, accuracy and a highly reliable mine destruction capability. Accuracy is of particular importance, because the whole object of minehunting is to provide safe navigation channels with a minimum of delay. This can be done either by finding and marking areas where no mines have been laid, or by destroying the mines in a carefully defined area.

To achieve the necessary very high standards of navigational accuracy, the mine-hunting sonar is integrated into a specially designed command and navigation sub-system. Important elements of the system are a pilotage radar, used to take range and bearings of reference short-scope buoys, and a minefield plotting table.

The other essentials in a properly integrated mine-hunting system are:

(a) a mine-destruction capability,

(b) adequate communication facilities to maintain continuous contact with other vessels in the force and to provide control of the mine destroying team,

(c) sophisticated propulsion and manoeuvring ability to enable the craft to navigate with precision at low speed under coastal tide conditions.

Sonar operators at the display units of the mine-hunting sonar system

THE PLESSEY COMPANY LIMITED
Electronics Group
Ilford, Essex, England
Telephone: 01-478 3040 Telex: 23166

1969

Optic/electronic systems

Periscopes, distress buoys and compass test tables

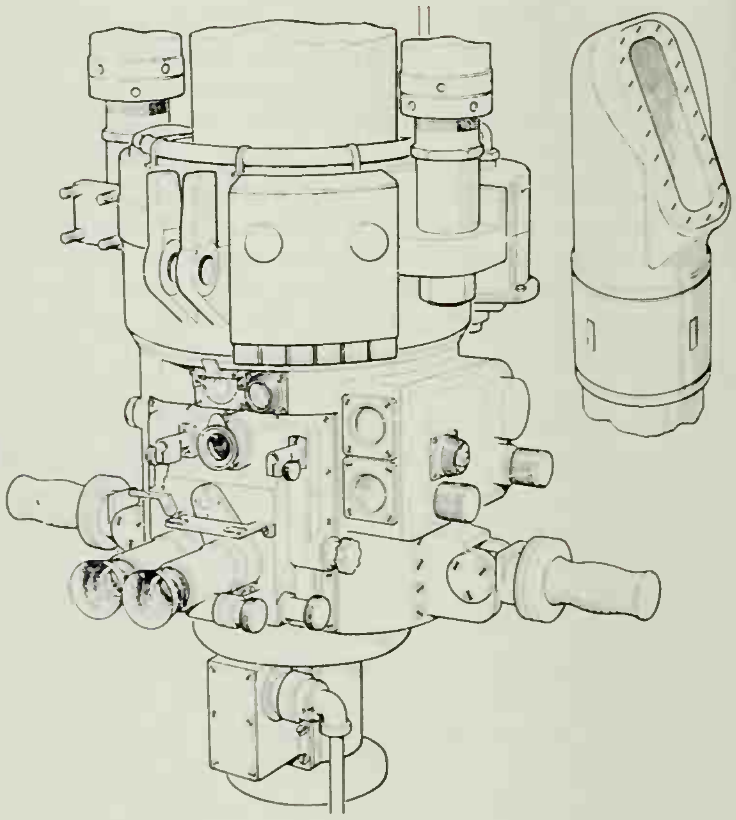
Submarine periscopes

Submarine periscopes for small, medium and large ocean-going submarines are produced by Barr & Stroud Limited, and these incorporate the following special features in their basic design: optical anti-vibration, wire-heated top window with thermostatic control, bearing transmission, true and relative bearing scales, and sextants.

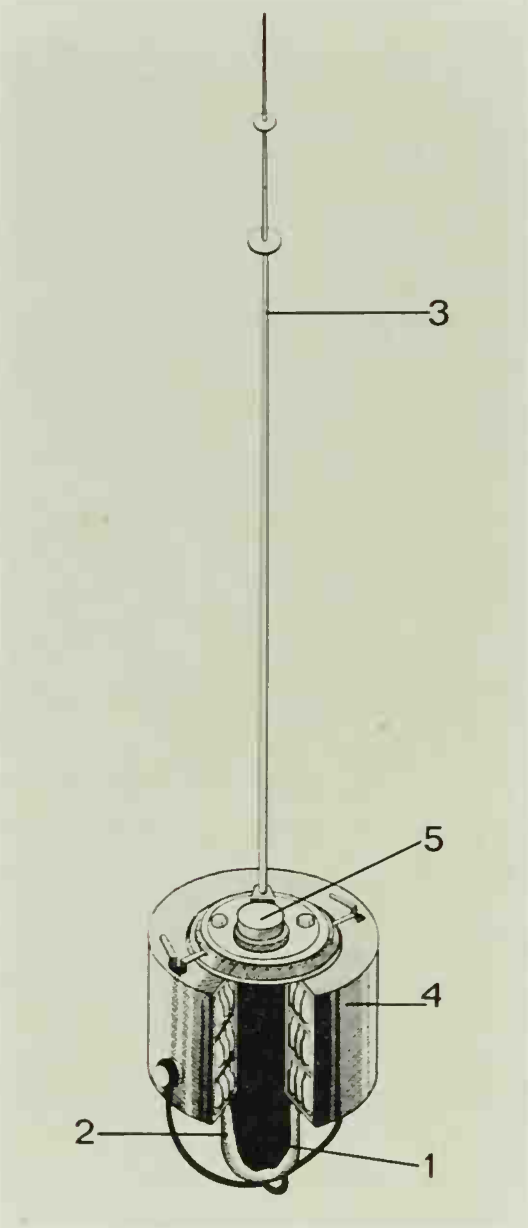
Search periscopes have binocular viewing for optimum viewing comfort under poor light conditions or during long periods of watch-keeping; facilities for high-quality motorised or polaroid camera photography can be provided.

Attack periscopes have monocular viewing systems allowing a smaller diameter tube upper end to be used, thus minimising tube exposure above water.

Combined search/attack periscopes of 180 mm tube diameter have been designed for smaller submarines in which only one periscope can be fitted. These utilise a special tube upper end of minimal size which can have either a combined search/attack head or a smaller diameter attack head. All periscopes provide rotation in azimuth and variation of elevation.



Right: Submarine periscope
Left: Submarine distress buoy



Indicator unit for submarine distress buoy

The submarine distress buoy is a self-contained equipment which is released from a submarine in distress. A submarine normally carries two of the buoys which are tethered to it by steel cables stowed on free-running drums. The buoy consists of an indicator unit (1) sealed in a pressure vessel (2), a whip antenna (3) and a flotation unit (4). The indicator unit transmits a preset code sequence on HF and UHF international naval distress frequencies, at the same time flashing a high-power lamp (5).

The equipment is completely transistorised and its comparatively low current consumption results in an endurance of at least 72 hours from a mercury cell type battery pack.

Magnetic compass test tables

ZJ4 and ZJ5 magnetic compass test tables have been designed and produced by Barr & Stroud Limited for the Admiralty Compass Observatory. ZJ4 is used for testing marine compasses to the latest International Standards Organisation Specification; the smaller ZJ5 is used for testing aircraft and hand-held compasses.

The materials used in these instruments have been selected for their stability, durability and non-magnetic characteristics. Electric motors for the turntable drives have been specially selected for their closely contained magnetic fields.

Right: Magnetic compass test table in use

BARR & STROUD LIMITED
Caxton Street, Anniesland,
Glasgow W3, Scotland
Telephone: 041-954 9601
Cables: Telemeter Glasgow Telex: 778114

BARR AND
STROUD

Data transmitters

for underwater equipment

Synchronised acoustic transmitter Type 4

The RDL Type 4 synchronised acoustic transmitter (SAT) has been developed as a comprehensive unit providing in one package all the facilities available from existing Types 1, 2 and 3, with the added facility of 'real time' outputs. It operates from ac or dc supplies in the range from 14 V to 150 V without adjustment.

Its intended use is as a signal source for sonar transmissions from torpedoes, torpedo exercise heads and underwater research vehicles, to enable these vehicles to be tracked acoustically in three dimensions.

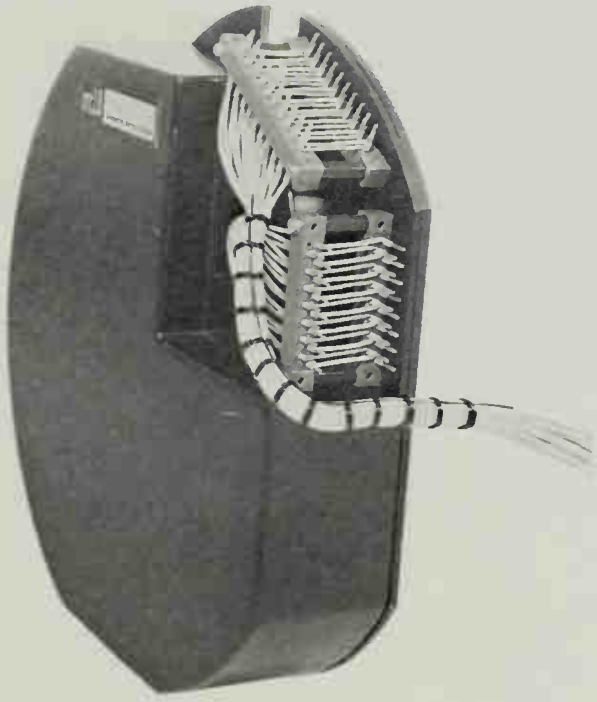
For tracking purposes and to assist in the evaluation of certain data, synchronisation of the internally generated clock pulse on a number of similar units must be carried out. Synchronisation is effected via UHF radio link. One important advantage of the Type 4 SAT is that clock-pulse generator stability is achieved within one minute of switch-on at any temperature over the operating range. Long warm-up periods are therefore eliminated.

Micro-welded multi-layer polyester base circuit boards and encapsulation of the components, together with wire-wrapped pin interconnection techniques contribute much toward the high reliability record of this equipment.

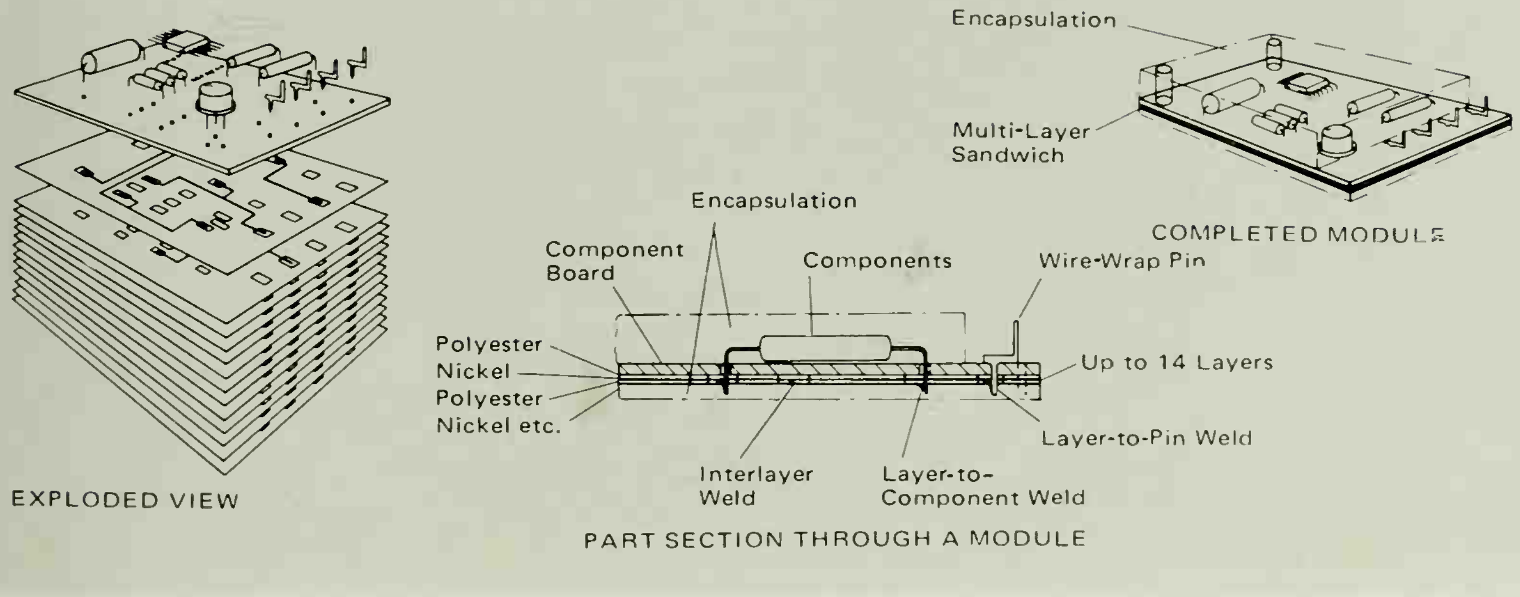
The Type 4 'A' unit is illustrated but an alternative 'B' version has been developed for use in equipment where space is at a premium. This alternative unit is electronically similar to the 'A'-unit but part is mounted on a pressure-proof case containing a beeper unit (fitting beeper apertures currently in use) and a part elsewhere within a system. The two sub-units are interconnected by cable and multi-pin plugs and sockets.

A panel of wire-wrap pins incorporated in both versions enables selection of the possible modes of operation. These are:

(a) SAT output frequency variable over the range from 10 to 100 kHz to cover UK/German/AUTEC requirements
(b) Short-range transmitter in use or inhibited
(c) Depth telemetry in use or inhibited
(d) Resistance or voltage-type depth transducer.



Type 4 synchronised acoustic transmitter, model A

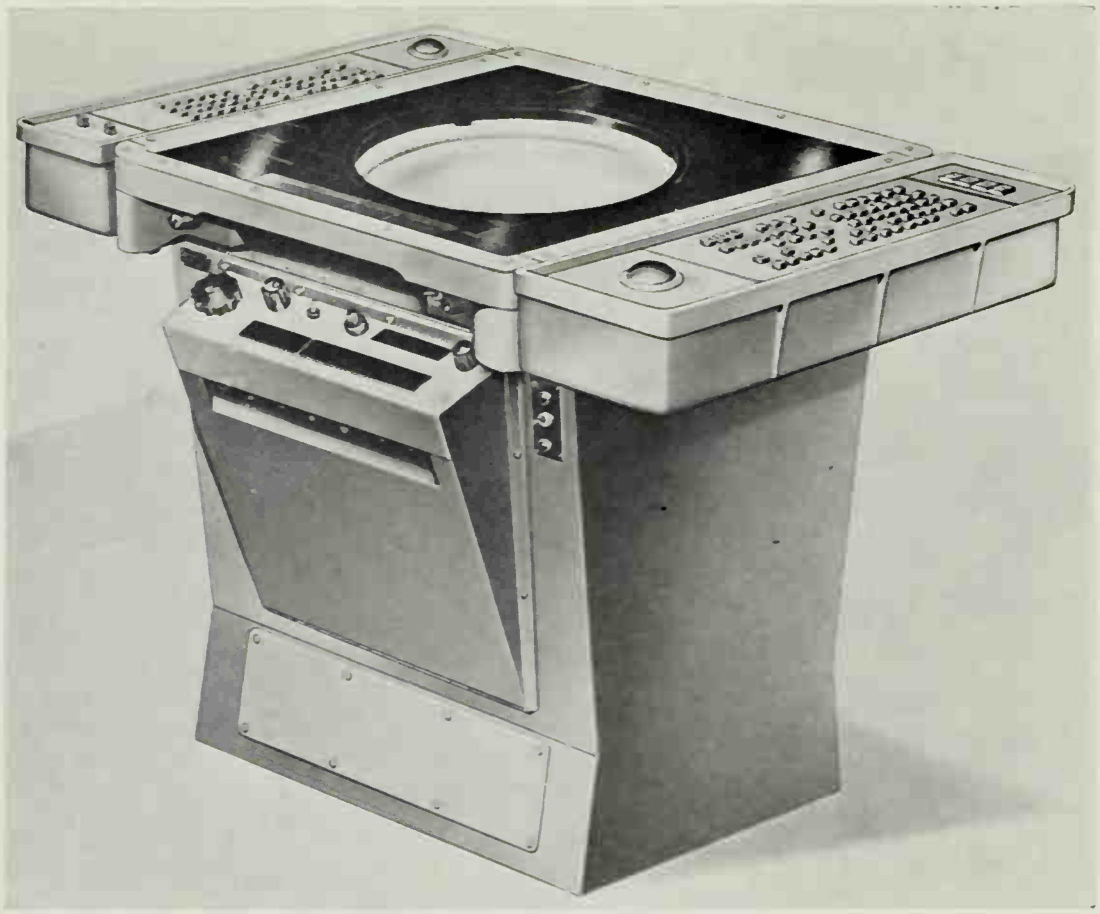

Encapsulation
Multi-Layer Sandwich
COMPLETED MODULE
Encapsulation
Component Board
Components
Wire-Wrap Pin
Polyester
Nickel
Polyester
Nickel etc.
Up to 14 Layers
Layer-to-Pin Weld
Interlayer Weld
Layer-to-Component Weld
EXPLODED VIEW
PART SECTION THROUGH A MODULE

Typical micro-welded circuit board assembly

RECORDING DESIGNS LIMITED
Blackwater Station Estate, Blackwater, Camberley, Surrey, England
Telephone: Camberley 24622 Telex: 85272

Section 4

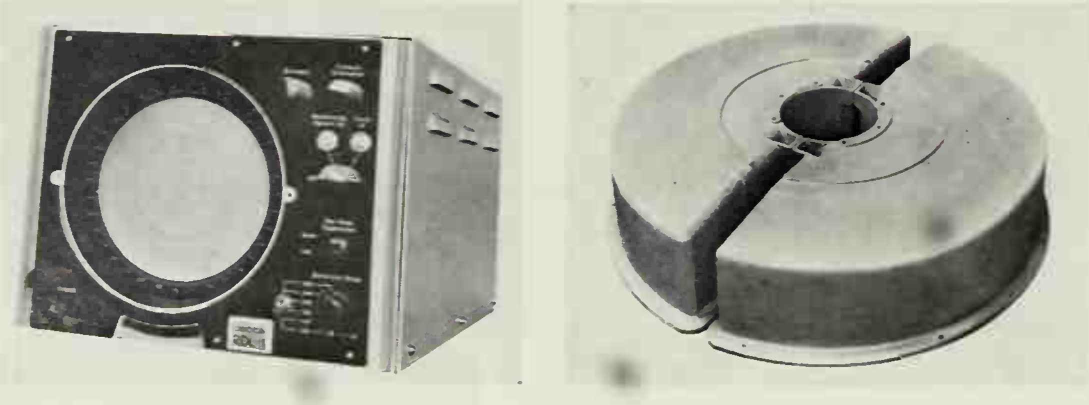
Surface sensors, control systems and weapons



Deccascan display

Decca ONA 12 optical navigation attachment on 12 in true-motion display

Decca D202 ONA optical navigation attachment



RDL display and aerial

Marine radar

for navigation and pilotage

Decca marine navigational radar, both standard and specialised equipment, is in use by over 60 of the world's navies. A comprehensive range of radars and displays, suitable for a wide variety of naval vessels and applications, provides the high performance and high standards of reliability necessary for the main navigational and tactical roles. With these radars a range of simple practical attachments provides additional facilities for high-speed navigation, tactical plotting, outputs to weapons systems and precision ranging and control for surveying and oceanography. Some typical naval radar systems are described below with details of the main items of equipment employed.

Fast patrol boat system

This is 305 mm (12 in) true-motion navigational radar fitted with an optical navigation attachment (ONA 12) to assist in compiling the local tactical plot, providing an aid to high-speed navigation, blind pilotage and exercise records.

Decca Transar TM626

A 305 mm (12 in) true-motion radar used with ONA on fast patrol boats, it is one of four radars from the Decca Transar Group 6, part of a complete range of transistorised radars. The TM626 comprises a display unit, 25 kW transceiver and 183 cm (6 ft) slotted waveguide aerial. The display can also be combined with a 10 kW transceiver and/or 274 cm (9 ft) slotted waveguide aerial.

The display operates on eight ranges from 1 to 90 km (½–48 nm) and offers five types of relative and true-motion presentation. A variable range marker is provided integral with the display unit.

Excellent range and bearing accuracy make the radar highly suitable for both navigational and tactical roles.

ONA 12 optical navigation attachment

The body of the ONA 12 is fixed on the face of the plan position indicator (PPI) like a reflection plotter or visor (which it replaces) to provide a mini-chart projection unit. This unit is provided with a polaroid shutter facility to control the light intensity of the chart or diagram superimposed in the plane of the PPI.

Hovercraft system

A simple high-speed navigational and tactical manoeuvring system is provided by the Decca D202 radar used in association with the 202 ONA optical navigation attachment.

A more sophisticated and comprehensive system, called Sealane and suitable for larger high-speed craft, is also available.

Decca D202 152 mm (6 in) relative-motion radar

As used with ONA in hovercraft. The Decca D202 was the world's first transistorised marine radar, introduced in 1963. The radar comprises a display unit with an effective viewing area of 190 mm (7½ in) with magnifier, a 3 kW transceiver and a 122 cm (4 ft) slotted waveguide aerial. A transistor inverter is available for 24 V dc installations.

The display, which can be bulkhead, pedestal, deckhead, or table-mounted, operates on six ranges from 1 to 45 km (½–24 nm).

The D202 is compact and economical, with low power consumption. Its high performance and reliability have been proved in service, and over 5000 of these radars have been ordered for installation in small vessels of every type.

202 ONA optical navigation attachment

The main body is fixed on the face of the D202 like the standard visor which it replaces. It consists of a light-proof chart unit with an own ship pencil marker operated by a footswitch. Access to the chart unit is available for recording radar surveys for future use. The chart is aligned with the radar picture by rolling-ball control to give present position and direct indication of position relative to planned track.

A detachable rotatable disc controlled by a thumb-wheel is also available to assist in high-speed tactical manoeuvres. Alternative inserts for search and weapon profiles may also be used as required. The D202 radar for hovercraft use is fitted with variable radar scaling for matching the chart scale required.

Frigate system

A modern frigate requires a high-definition surface warning system that can be integrated with the operation room (combat information centre) for tactical plotting, helicopter control, and co-ordination of forces as well as for providing the out-station navigational display for the bridge.

The Naval JUA display system associated with the Decca Transar and 978 radars has been developed to meet these requirements and has been evolved to meet the varying requirements of anti-submarine operations, manoeuvring and pilotage and other radar facilities to support the general-purpose frigate such as the Leander Class.

In addition to providing the basic radar navigational picture, the display system can, by the interswitching of radars, also provide target indication and the close air picture for differing radar inputs. Add-on units include the true-motion computer and the optical plotting unit for helicopter control facilities. A sector transmission unit is also available. This standard Royal Navy frigate system is compatible with helicopter, transponder, sonar, target indication, and plotting table sub-systems. All units have been designed to meet military specification and have been proven in extensive operational practice.

Deccascan display

The Deccascan display, which has been specially designed for the CAAIS type of naval system described elsewhere in this Catalogue, is a 406 mm (16 in) PPI conference type display and is compatible with the Ferranti FM1600B computer (also described in this catalogue). Each display is fitted with two Ferranti keyboard and rolling-ball units, which enable two operators simultaneously to carry out independent functions, each with his own tabular readout which he can position as required. A bulkhead-mounted power supply unit is supplied, requiring 50 W, and 200 W per display console. The overall dimensions of the display unit are 98 cm (38·6 in) high, 107 cm (41 in) wide and 71 cm (30 in) deep; the weight is 150 kg (331 lb).

The Deccascan displays can be operated independently of the computer as normal 'raw radar' PPI displays if required. True-motion corrections are normally applied by the computer to each display individually: separate naval true-motion units can be fitted if required to apply these corrections when the computer is not in use.

Electronic warfare equipment

The Decca RDL Series of passive electronic warfare equipment provides reception of pulsed radar transmissions in the band 2–11 GHz to give warning of the approach of aircraft, ships and submarines transmitting on radar in this band, also their bearing and indication of radar characteristics. The equipment can be installed in all classes of naval vessels and, suitably adapted, in helicopters, fixed-wing aircraft or military vehicles.

The equipment is all-solid-state, except for the cathode ray tube (CRT) displays, and is of light weight and small size; it is simple to install in new vessels or retrospectively.

The bearings of received signals are displayed on a compass-stabilised CRT, which also provides an indication of the sweep pattern or change of behaviour of the transmitting radar. More elaborate equipments provide for measurement by the operator of parameters of selected signals, thus permitting identification of the radars concerned.

A special simulator is available as a training aid for electronic warfare operators.

Hydrography and oceanology

Precision ranging system (PRS)

The Decca Alpine precision-ranging attachment, used with Decca Transar or other radars, permits the simultaneous measurement of ranges of two different radar echo or transponder targets to a high degree of accuracy.

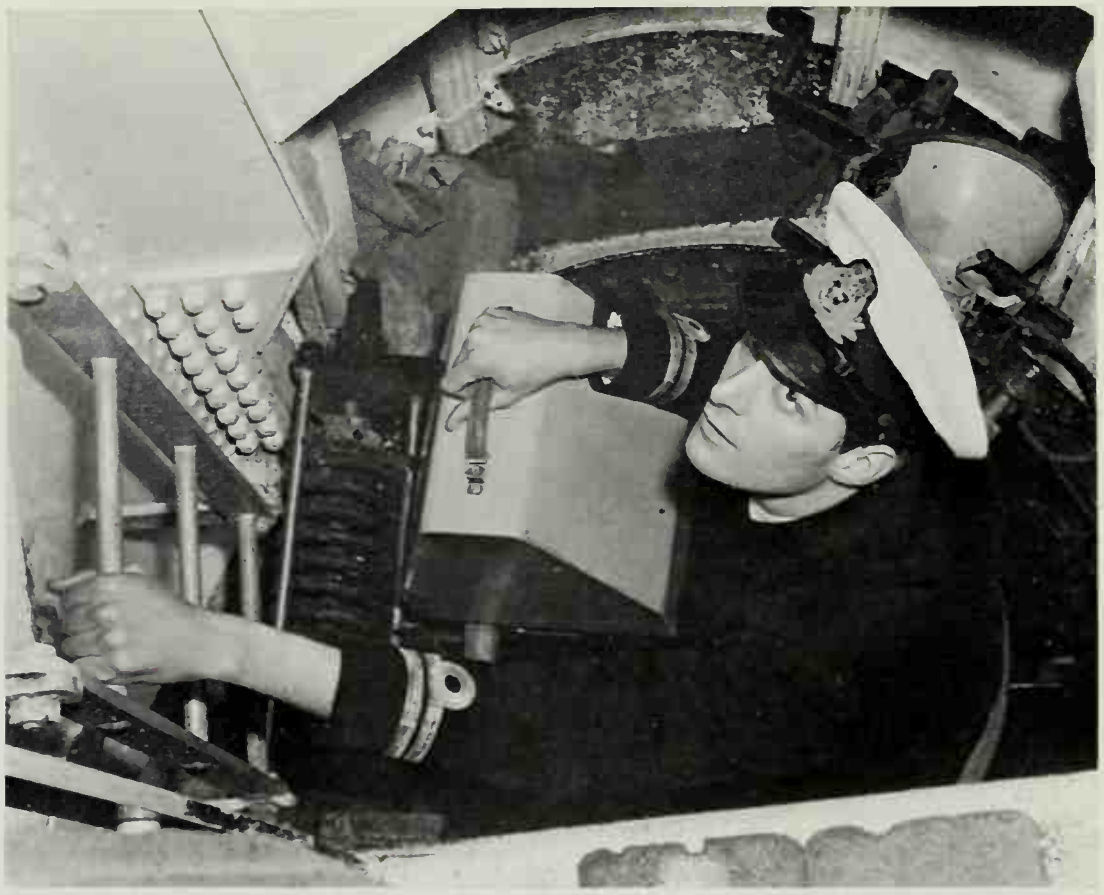
A digital radar ranging unit is also available which gives nixie display of the two ranges, as well as an electrical output of each range in positive logic 1-2-4-8 binary-coded decimal code, or as required, for recording or input direct into a computer. In addition, a miniature accurate ranging system (MARS) is available. This is a small low-priced system for accurate ranging on two selected targets.

Although any geographical points can be used as targets, it may be desirable to assure unambiguous targets (no reflections) or, in applications far from land, buoy-mounted targets may be required. The Alpine transponder associated with the systems is small, light-weight, transportable and battery-operated. It transmits a variable time-coded double-pulse for positive identification which produces distinct bright blips on the radar display.

The precision ranging system may be used in conjunction with the Decca Navigator Hi-Fix accurate fixing system.

DECCA RADAR LIMITED
Marine Division
Decca House, 9 Albert Embankment, London SE1, England
Telephone: 01-735 8111 Cables: Decradar London SE1 Telex: 28588

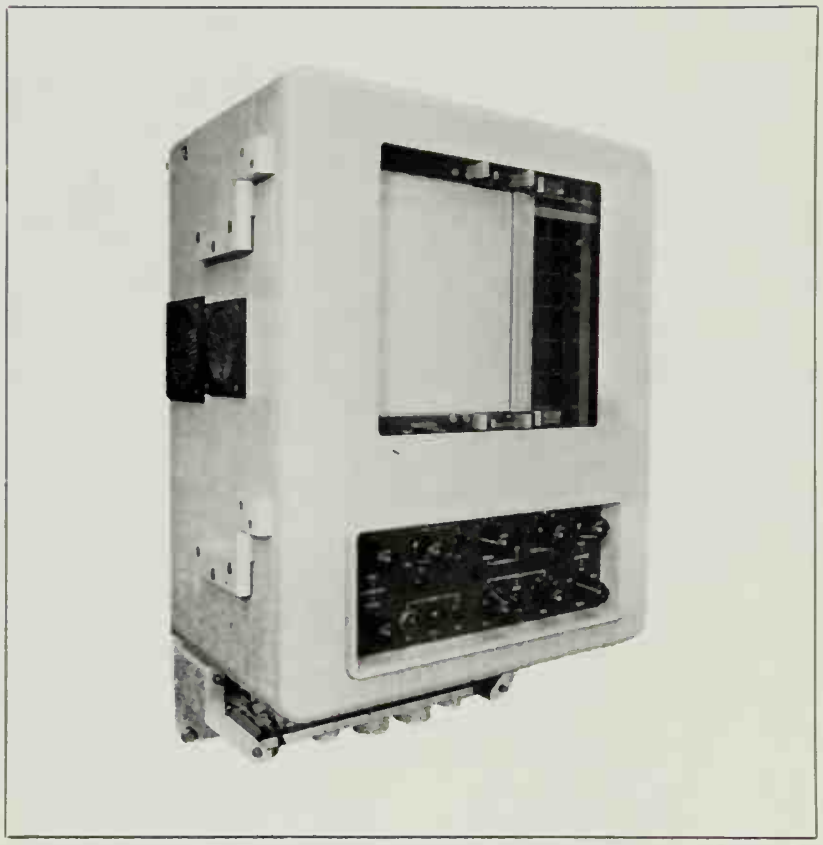
1966
1967
1968

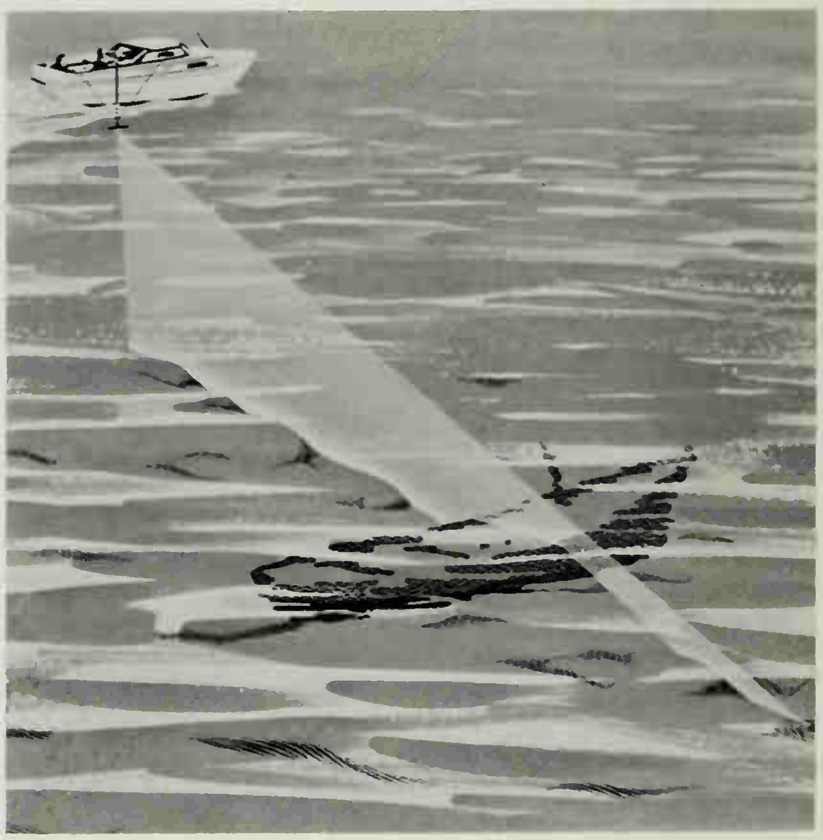


Radar

Left: The display unit of the Kelvin Hughes submarine bridge radar weighs only 16 kg (36 lb) and is easily passed through the conning tower hatch when diving or surfacing

Below: A minesweeper fitted with Kelvin Hughes Type 975 high-definition surface warning radar

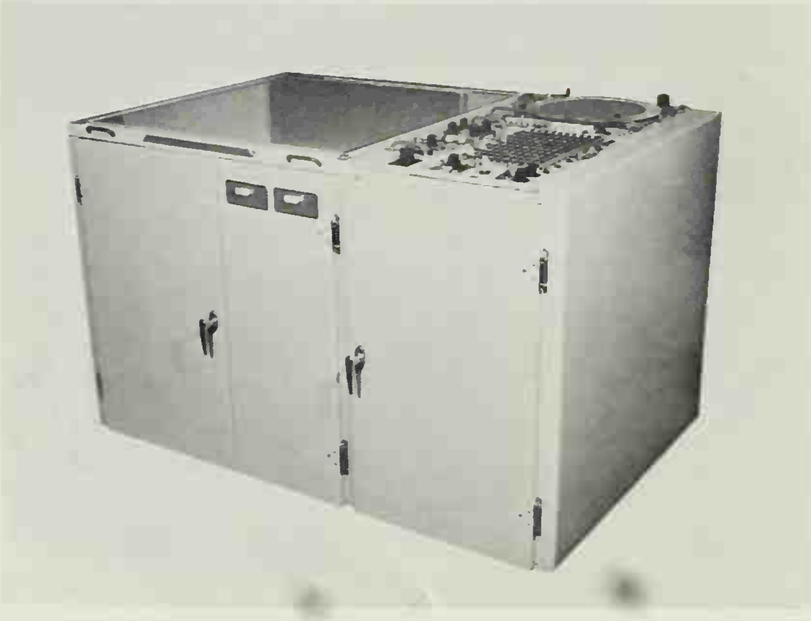




Sonar equipment

The Kelvin Hughes Type 778 general-service navigational echo sounder currently under development incorporates both a recorder and a digital bridge unit

The Kelvin Hughes transit sonar transmits a fan-shaped beam and records an acoustic plan of the seabed. This artist's impression shows the principle of operation



Photographic equipment

Left: Outfit JYC, supplied to the British Ministry of Defence (Navy Department) provides on a flat screen of 810 mm (32 in) dia a display of radar navigational and other information and incorporates a 16 mm rapid photographic processing projector

Naval electronics

Radar, racon, sonar and photographic equipment

Radar equipment

Radar Type 975

Type 975 is a lightweight X-band high-definition surface-warning radar, developed specially for use in minesweepers, fleet auxiliaries and other naval craft with navigation as its prime function. It is also specially adapted for mine-hunting in conjunction with a suitable plot and underwater detection equipment. True-motion facilities are available. Seven range scales from 1·4 to 90 km (0·75 to 48 nm) are provided on a 305 mm (12 inch) display.

Submarine bridge radar

Outfit JQ is a lightweight compact radar display weighing only 16 kg (36 lb) and is easily passed through the conning tower hatch when diving or surfacing. Primarily intended for use when entering or leaving harbour, the transistorised display operates in conjunction with existing submarine radar equipment. Power cables may be connected to waterproof sockets on the submarine bridge or to sockets within the pressure hull. The display operates directly from the submarine radar mains and a separate power unit is not required. Four range scales from 1·8 to 28 km (1 to 15 nm) are provided and the equipment has a 241 mm (9 inch) display.

Radar Type 1006

Currently under development, Type 1006 is designed to meet operational and reliability requirements of the Royal Navy for the foreseeable future. It incorporates solid-state electronics throughout, except for the magnetron and cathode-ray tube and is compatible with existing complex naval radar systems. The 305 mm (12 inch) display has range scales to 118 km (64 nm) and electronic digital readout of range and bearing with electronic transmission of this information to ancillary equipment.

Racon

The Ursa Minor racon is a radar responder beacon of very small size and light weight incorporating solid-state electronics throughout. The device is quiescent until triggered by a ship's radar transmission, when it transmits a plain or coded signal. This is displayed on the tail of the source echo on the ship's radar screen and gives precise identification of the seamark or landmark fitted with the racon.

Sonar equipment

Echo sounder Type 778

The Type 778 general-service navigational echo sounder currently under development incorporates both a recorder and a digital bridge unit. The recorder may be sited remote from the bridge unit, and each instrument is connected to its own transducer. A main 10 kHz transducer is used for the recorder and a shallow-water 48 kHz transducer for the bridge unit. The instruments are interswitched so that shallow-water readings may also be shown on the recorder.

Precision depth recorder

This is designed as an oceanographic instrument for use in survey ships. It uses the Type 778 transmitter and is operated in conjunction with this equipment.

MS36 hydrographic echo sounder

Designed to meet the exacting requirements of the Hydrographic Survey Department, the MS36 provides a sounding system with ample power giving first-class definition. Its associated automatic digital output units, used with a radio navigation system, enable depth and position to be logged automatically. A visual digital readout is also given. The MS36 consists of three portable units with inboard or outboard transducers.

Transit sonar

Designed for application in hydrography, dredging, salvage and similar works, this equipment transmits a fan-shaped beam from a fixed transducer. The beam is narrow in the horizontal plane and is directed to one side of the vessel's track. As the ship advances, successive echos are recorded and accumulate to form an acoustic plan of the seabed showing rock outcrops, sand waves, wrecks, other objects, changes in seabed material and texture. Two range scales are available: 0–275 m (0–300 yd) and 0–550 m (0–600 yd).

Photographic equipment

Rapid film processor

Rapid photographic processing equipments are designed for large-screen display and recording of fast transient signals. Instrumentation is fully automated operationally and adapted for computer control. The main features are a camera, processor and projector usually built as one unit and designed either for 16 mm or 35 mm film. The maximum renewal rate is limited only by the minimum time necessary for the photographic processing and this is equal to the time delay between recording and display.

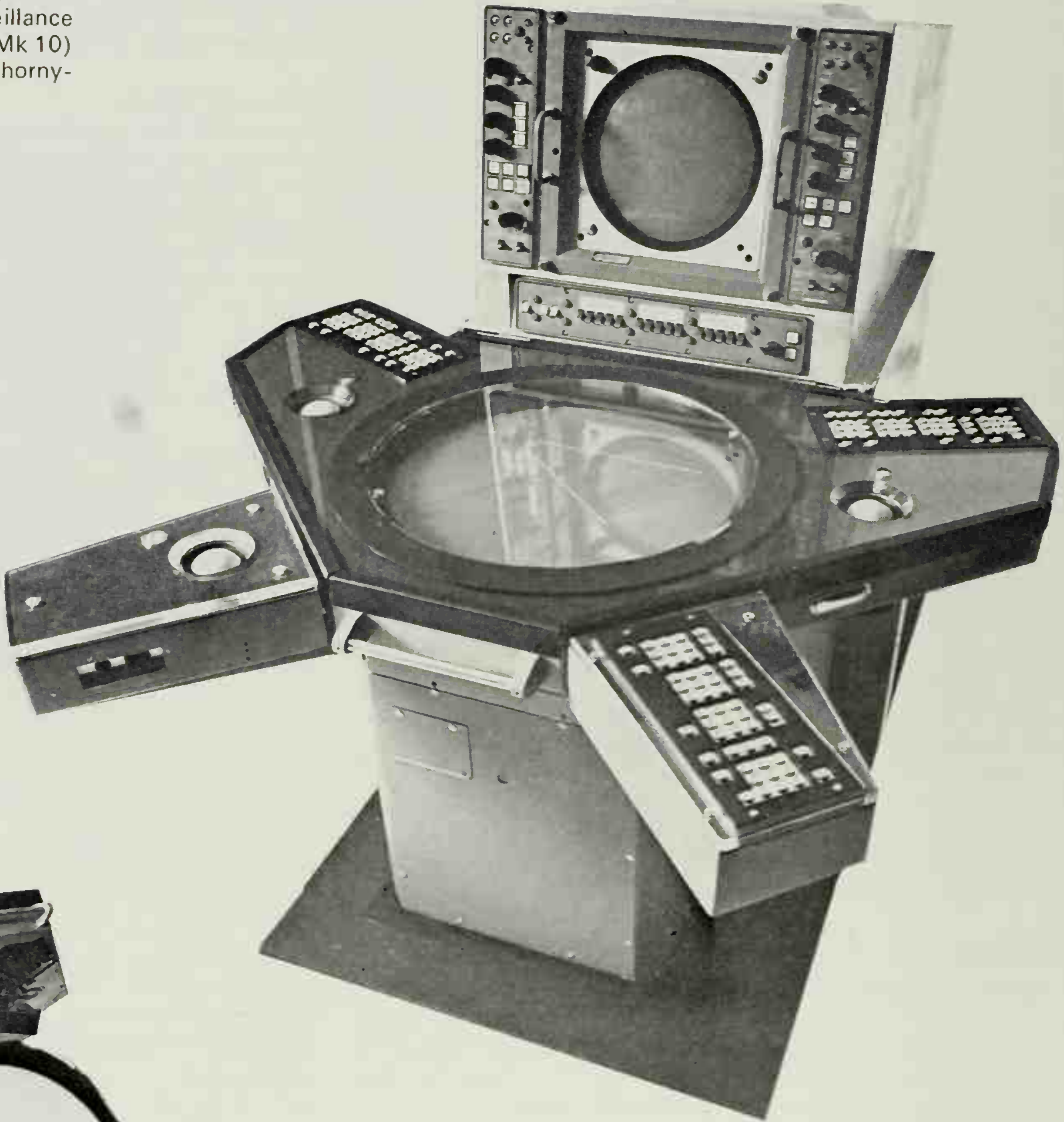
Minimum black-and-white processing times are 4 and 6 seconds for negative and positive respectively, and 20 seconds for colour. The overall definition obtained is some 1500 television lines for 35 mm film, 1000 lines with 16 mm film, and 700 lines for colour film. The film record produced is of archival quality.

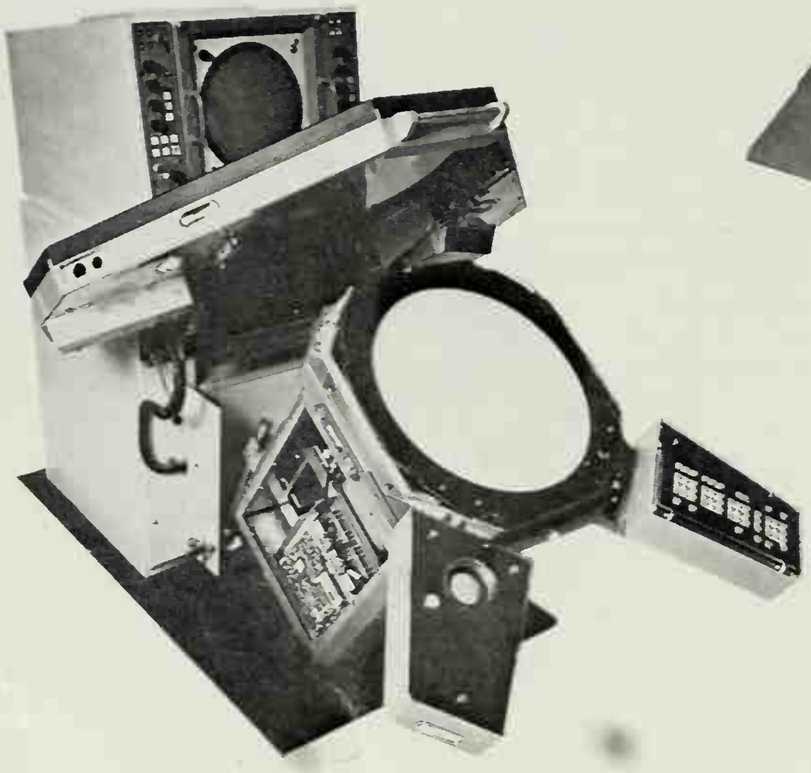
In addition to equipment which incorporates projection facilities, Type 11 and 12 Mk 2 processors, designed for the British Ministry of Technology, are capable of processing aerial reconnaissance film up to 240 m (9·5 in) wide and passing it for analysis at speeds in excess of 36 m/min (120 ft/min).

KELVIN HUGHES
A Division of Smiths Industries Ltd
New North Road, Hainault, Ilford, Essex, England
Telephone: 01–500 1020 Cables: Marinst Ilford Telex: 896401

1967
1968

Above: Vosper Mk 5 fast destroyer IIS *Saam* is fitted with Plessey surveillance radar AWS-1 and integrated IFF (Mk 10) system (picture courtesy of Vosper Thornycroft Group)





A Plessey three-man tactical display for ADA systems. A fully automated digital display with a 55 cm (22 in) direct-viewing horizontal labelled radar picture backed by a full alpha-numeric tote display. The display operates in conjunction with 30 cm (12 in) digital display consoles to provide comprehensive and versatile display systems for destroyers and frigates. Full accessibility for maintenance is ensured by hinged table-top and tilting viewing unit, as shown at the left

Naval radar systems

and satellite communication systems

Plessey AWS series of naval radars

The Plessey AWS series of surveillance and early warning radars are high-performance S-band radars intended for service in destroyers, frigates and corvettes. They fulfil the following operational roles: air warning, aircraft control, surface warning, navigation and air and surface target indication.

The AWS-1 employs two transmitter-receivers, operating in frequency diversity through a single, lightweight aerial. It can also be supplied with a single transmitter-receiver.

Coastal radar applications

A land-based variant of the Plessey AWS-1 has been supplied for coastal surveillance and is currently being installed by the Royal Navy for helicopter control purposes.

Naval IFF Mk 10 (SIF) equipment

The Plessey IFF Mk 10 SIF equipment package uses silicon integrated circuits extensively and incorporates the latest techniques in micro-miniaturisation, to provide a compact and highly reliable system. Operation with full SIF decoding of 4096 codes on each of Modes 1, 2 and 3A is a feature of this system. Facilities are available for both passive and active decoding. The package includes a companion transponder.

Action information systems

Plessey Radar is a leader in the field of completely integrated display and data-handling systems for all classes of ship, from small corvettes to guided-weapon destroyers.

First-class action information systems enable the fighting efficiency of a ship to be dramatically increased. An integrated action information system supplies the command with constantly up-dated information on air, surface and sub-surface situations and can assist in, or control, threat evaluation and weapon assignment.

The degree of automation and computer assistance incorporated in the system may vary according to the type of ship, its weapons system and its operational role. A Full Action Data Automation (ADA) system would be required for a guided missile destroyer, whereas a manually operated display system with or without a computer would be installed in a general-purpose frigate.

Plessey Radar has wide experience in the design, installation and integration of naval action information systems and is currently supplying equipment for systems to the Royal Navy for the Type 82 destroyer HMS *Bristol*, Type 42 frigates and Ikara-equipped Leander Class frigates.

Naval support services

The increasing complexity of warship design, particularly in the electronics and weapons systems areas, demands a detailed and well-planned schedule of maintenance and repair by highly qualified technicians.

Modern ships' electronics systems are sophisticated and are occupying more of the initial capital cost of a ship. Plessey Radar is offering a total support service to protect the customer's considerable investment and prolong the active life of his ship.

Backed by wide experience in naval electronics and refits Plessey Radar can offer a total support service covering both refitted and new construction warships. These services include:

Preventative maintenance schedules
Commissioning and setting to work of electronic equipment
Installation design services
Provision of ship or shore-based maintenance engineers
Training and instruction of technicians.

Plessey Radar will also undertake the complete project management of entire ships' electronics systems refits from the ship survey and resultant recommendations for refurbishment or replacement to sea trials and handover to the customer. Naturally the same responsibilities can be undertaken from installation design to customer acceptance in a new ship.

Naval satellite communications terminals

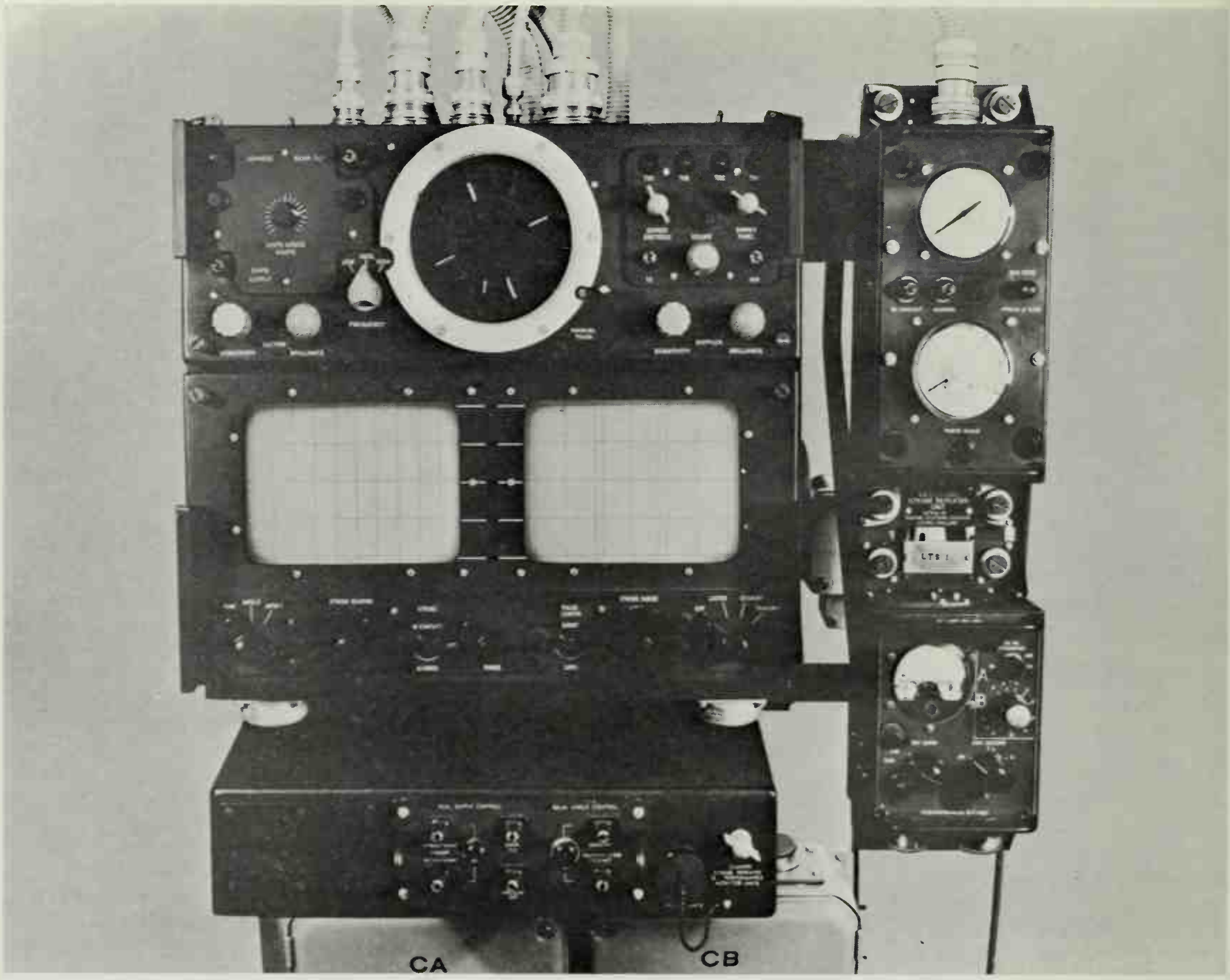
In conjunction with the Admiralty Surface Weapons Establishment, Plessey Radar Limited is the first company to design and manufacture a successful shipborne satellite communications terminal, as shown above. Installations aboard the two Royal Navy assault ships, HMS *Intrepid* and HMS *Fearless*, will provide a world-wide multi-channel telegraphy and voice communication capability to the fleet by means of geo-stationary military satellites.

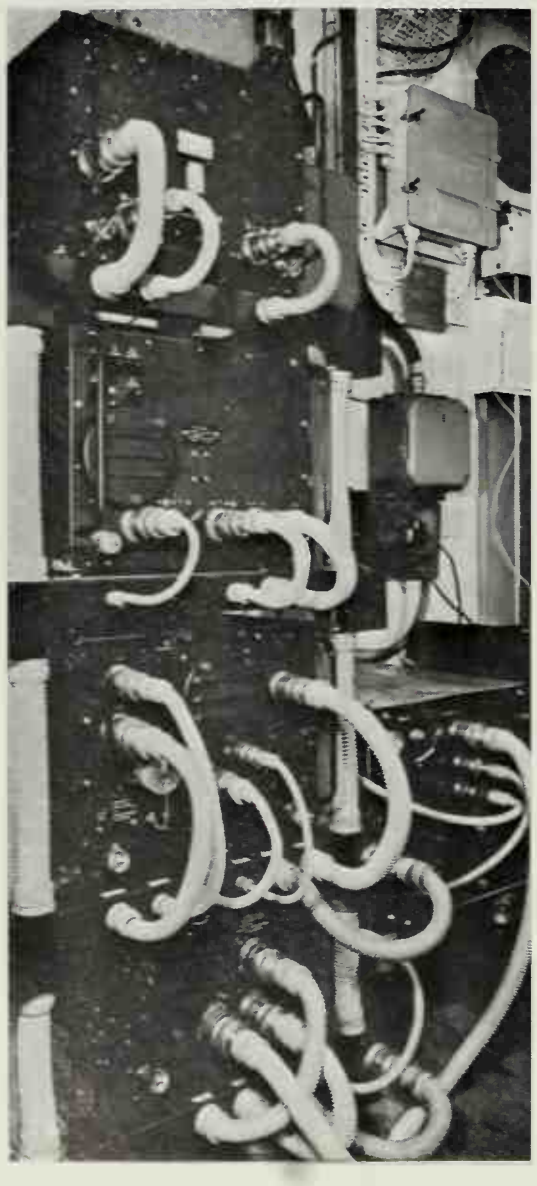
The 1·8 m (6 ft) terminal can be fitted aboard most types of warship down to frigate class.

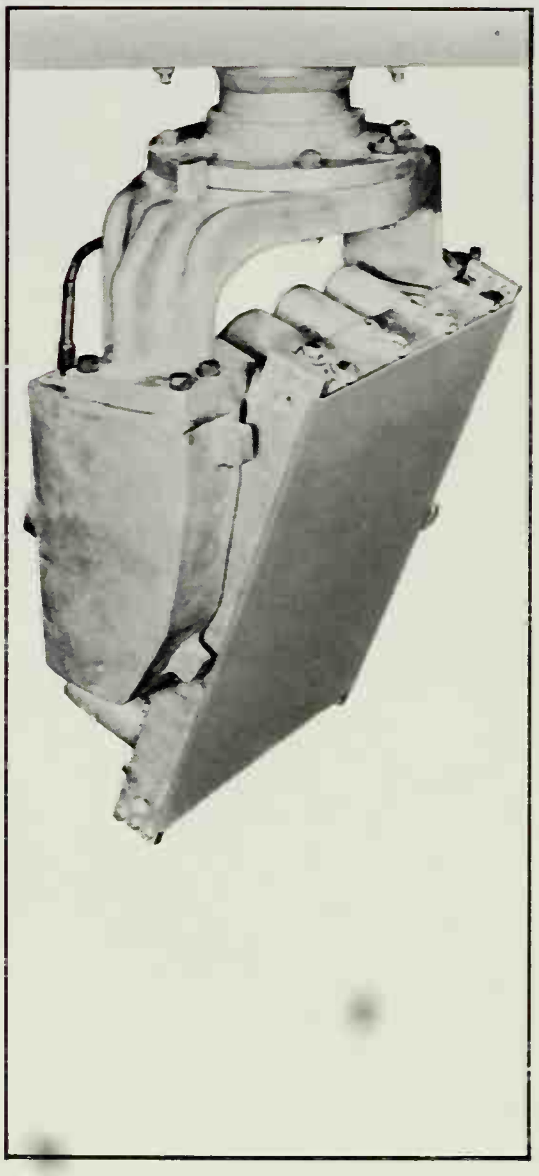
Plessey land-based radar and defence systems are described elsewhere in this catalogue.

PLESSEY RADAR LIMITED
Addlestone, Weybridge, Surrey, England
Telephone: Weybridge 47282 Cables: Plessrad Weybridge Telex: 262329

1969







Top: operator's console

Left: transducer head

Far left: electronic units

Small ship sonar

Plessey Type MS26 and MS27

Types MS26 and MS27 are the latest additions to the Plessey range of naval sonars. They have been designed expressly for one-man operation. Use of the latest fully transistorised circuits ensures high reliability, while modular construction techniques permit rapid maintenance and minimise loss of operational time. These new sets are much smaller and lighter than those currently in service. This not only makes important savings in shipboard space and weight, but renders MS26 and MS27 suitable for installation in small vessels down to patrol craft of 150 tons displacement. It is thus possible to provide small escorts and patrol craft with a primary sonar capability which, until now, has been possible only in the larger classes of escort. MS26 and MS27 also offer a means of economically providing secondary sonar capability in multi-role vessels.

Performance

The performance of any sonar is determined by many factors including transmitted power, receiver sensitivity, interference levels and transmission losses. The first two of these factors are under the full control of the designer and, in the case of MS26 and MS27, are optimised by the use of maximum transmitted power, high directivity index and a sophisticated and highly sensitive receiving and display system. Interference levels and transmission losses depend partly on the sea conditions prevailing at any time, but the effect of interference is minimised in both sonars by careful receiver design and hull outfits. Under slow-speed operation, when the background noise is that caused by the breaking and pounding of the waves equivalent to, say, sea state 4, the theoretical initial detection range can be calculated to be 6825m (7500yd).

Type MS26, general description

Plessey sonar Type MS26 is a self-contained sonar system for ships and patrol craft down to 150 tons. The equipment provides full 360 deg coverage in four steps of 90 deg and may be manually controlled to cover a particular sector or set to carry out an automatic search procedure. It incorporates a maintenance of close contact facility for tracking close or deep targets. A single operator controls the sonar through a special console. He is provided with three sources of sonar information:

(*a*) audio
(*b*) visual doppler
(*c*) visual sector

The doppler facility provides increased initial detection range and improved classification capabilities compared with conventional small ship sonar equipments. The MS26 transducer array is mounted within a Plessey hull outfit with a glass-reinforced plastic dome.

Type MS27, general description

Plessey sonar MS27 differs from MS26 only in its associated hull outfit. The MS27 transducer array is mounted in a Royal Navy hull outfit 19 or similar, which renders the equipment suitable for installation in small escorts down to about 750 tons displacement. Type MS27 can be used in the surveillance role in association with a separate fire control sonar within the same hull outfit. This enables the ship to continue surveillance for new threats while engaging a target already detected.

Types MS26 and MS27, electronics

Description	Width (cm)	Height (cm)	Depth (cm)	Weight (kg)	Width (in)	Height (in)	Depth (in)	Weight (lb)
Operator's console	53	43	30	26·5	20·9	16·9	11·8	58·4
Support frame	—	—	—	25·0	—	—	—	55·1
Doppler receiver	40	29·2	52	20·7	15·75	11·5	20·1	45·6
Sector receiver	40	29·2	38·0	10·8	15·75	11·5	15·0	23·8
Transmitter	29·2	19·2	52	13·7	11·5	7·5	20·5	30·0
Auxiliaries unit	40	29·2	51·0	27·1	15·75	11·5	20·1	60·0
Sonar power supply	43·2	38·1	50·1	73	17·4	15·0	19·5	160·0
Support structures	—	—	—	50	—	—	—	110·0
Interconnecting cables	—	—	—	50	—	—	—	110·0
Transducer assembly	44·5	99·6	53·4	100·0	17·5	40·0	21·0	220·0
Total weight	—	—	—	397·4	—	—	—	872·9

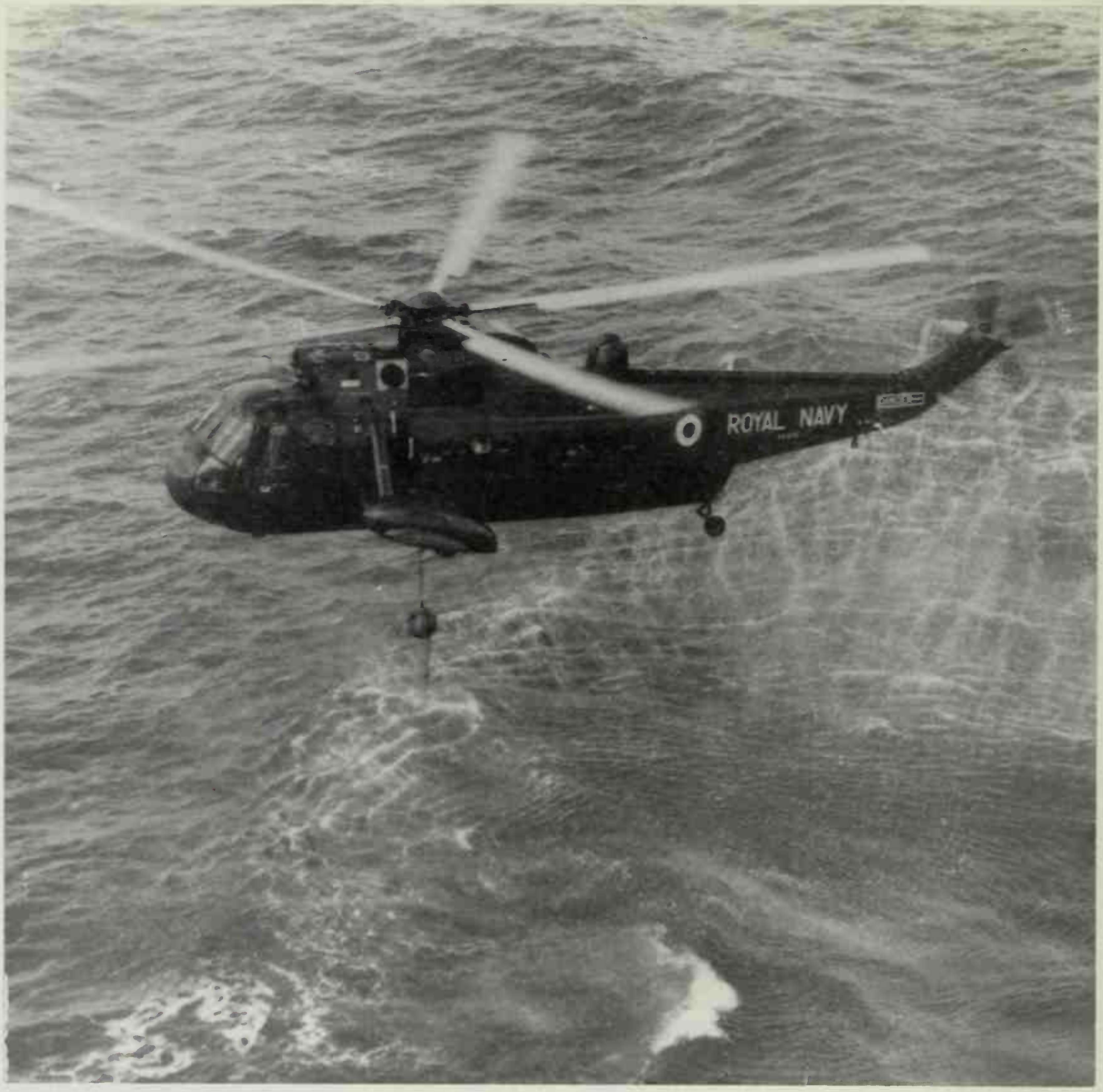
Type MS26, hull outfit

Description	Width (cm)	Height (cm)	Depth (cm)	Weight (kg)	Width (in)	Height (in)	Depth (in)	Weight (lb)
Hull outfit	80·0	137·3	140	1015	32·0	54·0	59·0	2240
Sonar dome	48·3	72·5	132		19·0	28·5	52·0	
Hydraulic power supply		—	—	136	—	—	—	300
Total weight	—	—	—	1151	—	—	—	2540

Note: Details of hull outfits suitable for use with MS27 are available on request

THE PLESSEY COMPANY LIMITED
Electronics Group
Ilford, Essex, England
Telephone: 01-478 3040 Telex: 23166

1969



One of the Westland Sea King helicopters of the Royal Navy making a sonar dip

Helicopter sonar Type 195

This equipment has been designed by the Ministry of Defence and manufactured by the Marine Systems Division of the Plessey Company. In conjunction with a high-definition radar, an aircraft tactical plot and an air-launched torpedo it provides the modern helicopter with the equivalent of a frigate's anti-submarine warfare fire power and plotting facilities. Type 195 Sonar is now in squadron service with the Royal Navy.

The 'dunking' sonar is fully capable of dealing with the modern submarine and has proved robust and reliable in service to the satisfaction of the Royal Navy.

Helicopter sonar unit

and computerised sonar ray trace indicator

Sonar has proved a most effective means of submarine location, while helicopters, with their outstanding manoeuvrability, are in many respects ideal platforms for anti-submarine warfare. The combination of the two, in the form of the Plessey Type 195 'dunking' sonar shown on the opposite page, has already proved highly successful in many trials under battle conditions.

However, sonar is based on the assumption that sound waves travel outwards in a straight line and at a fixed speed from the source. This is not always the case; temperature gradients, changes in salinity and other parameters affect the transmission of sound waves through water. Especially changes in temperature with increasing depth can reflect and refract sound waves to a considerable extent.

Acoustic ray trace indicator

The new Plessey Acoustic Ray Trace Indicator (ARTI) has been developed by the Marine Systems Division for the Royal Navy to apply automatically corrections due to such effects. The equipment, which is very compact, provides rapid corrections to the detection range of any sonar by using temperature/depth or velocity/depth profiles derived from suitable detectors. The indicated correction enables targets to be located with greatly improved accuracy.

ARTI can accept input data from any temperature or velocity-profile source, but is specifically designed to accept plots automatically from either the Royal Navy sound velocity recorder, or from the Plessey-Sippican expendable bathythermograph which is described in detail elsewhere in this Catalogue. The bathythermograph is already in service with ten navies.

The ARTI incorporates an analogue computer which integrates the sonar plot with the temperature/depth or velocity/depth data and predicts ray paths at one degree intervals within the sonar beam. Mounted independently, it is designed so that the specific parameters of any sonar equipment can be manually preset.

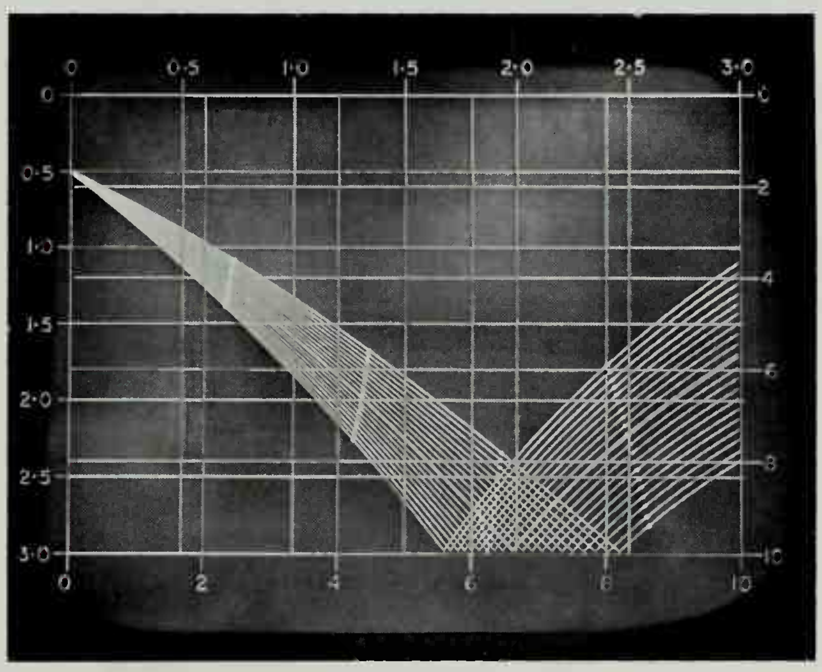
The equipment consists of three portable units, each housed in a separate instrument case:

Data converter: This unit contains the devices for data input setting from each of the possible sources, the input data store and the first stages of the computation. The overall case size is 441 × 356 × 251 mm ($17\frac{3}{8}$ × 14 × $9\frac{7}{8}$ in).

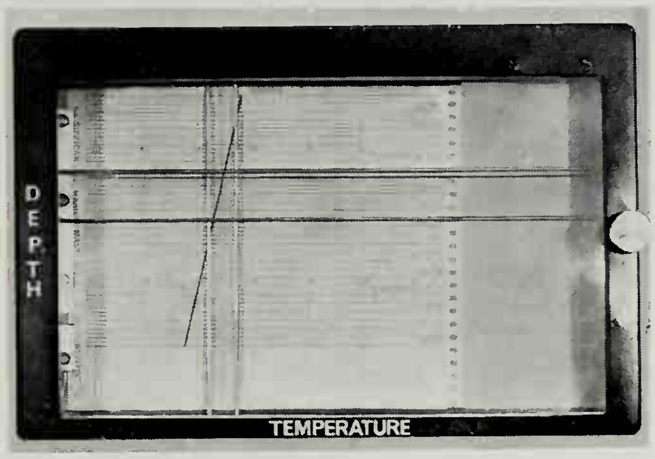
Sonar ray computer: This contains the major part of the computer, with the output display. Overall size is 441 × 356 × 480 mm ($17\frac{3}{8}$ × 14 × $18\frac{7}{8}$ in).

Accessory outfit: The third unit provides storage space for the polaroid camera and all connecting cables and accessories.

The power supply is 115 V ± 15 V, 45–66 Hz, or 230 V ± 15 V.



This display on an ARTI demonstrates the vertical coverage pattern derived from the simple batythermograph trace shown below



Simple sea depth temperature curve obtained on a Plessey-Sippican bathythermograph from an expendable probe

THE PLESSEY COMPANY LIMITED
Electronics Group
Ilford, Essex, England
Telephone: 01-478 3040 Telex: 23166

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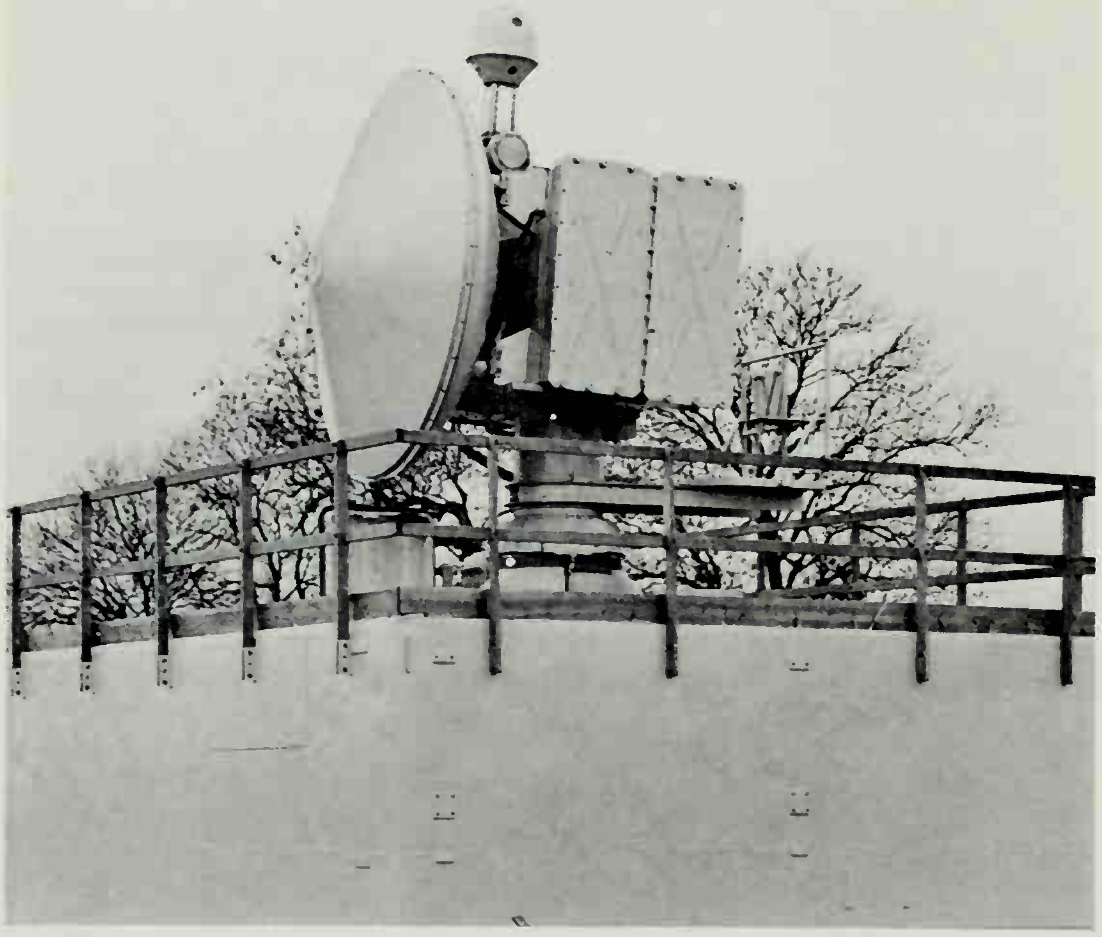


Left: Target tracking and illuminating radar for the Sea Dart guided missile system

Below: HMS *Kent* is one of the many ships fitted with Marconi radar and in service with the Royal Navy

Naval radar systems

and all associated equipment

Marconi Radar Systems Limited has always played an important role in meeting the Royal Navy's radar requirements. It has also designed and installed complete radar systems for Commonwealth and for foreign navies. The company has extensive experience in the development, design and manufacture of naval radar equipment for most operational requirements including long-range early warning, target indication and fire control. The equipments can be supplied as individual items or engineered into an integrated ship's system.

The company collaborates with the shipbuilders to plan the layout of radar equipment to suit the user's requirements and can undertake installation of the equipment if desired.

Marconi Radar Systems Limited is actively engaged in the development programme of the complete electronics system for Seawolf, a new generation of missile in the Royal Navy. The company will be responsible for the complete system electronic equipment, including surveillance radars, target-tracking radar, missile-gathering and guidance television, data-handling and display equipment and command guidance communications. The company is also responsible for all aspects of management and development co-ordination for the complete shipborne system.

The company has major sub-contracts for radar equipment which forms part of the new Sea Dart shipborne missile system, in particular the tracker/illuminator radar and the transmitter for the surveillance radar.

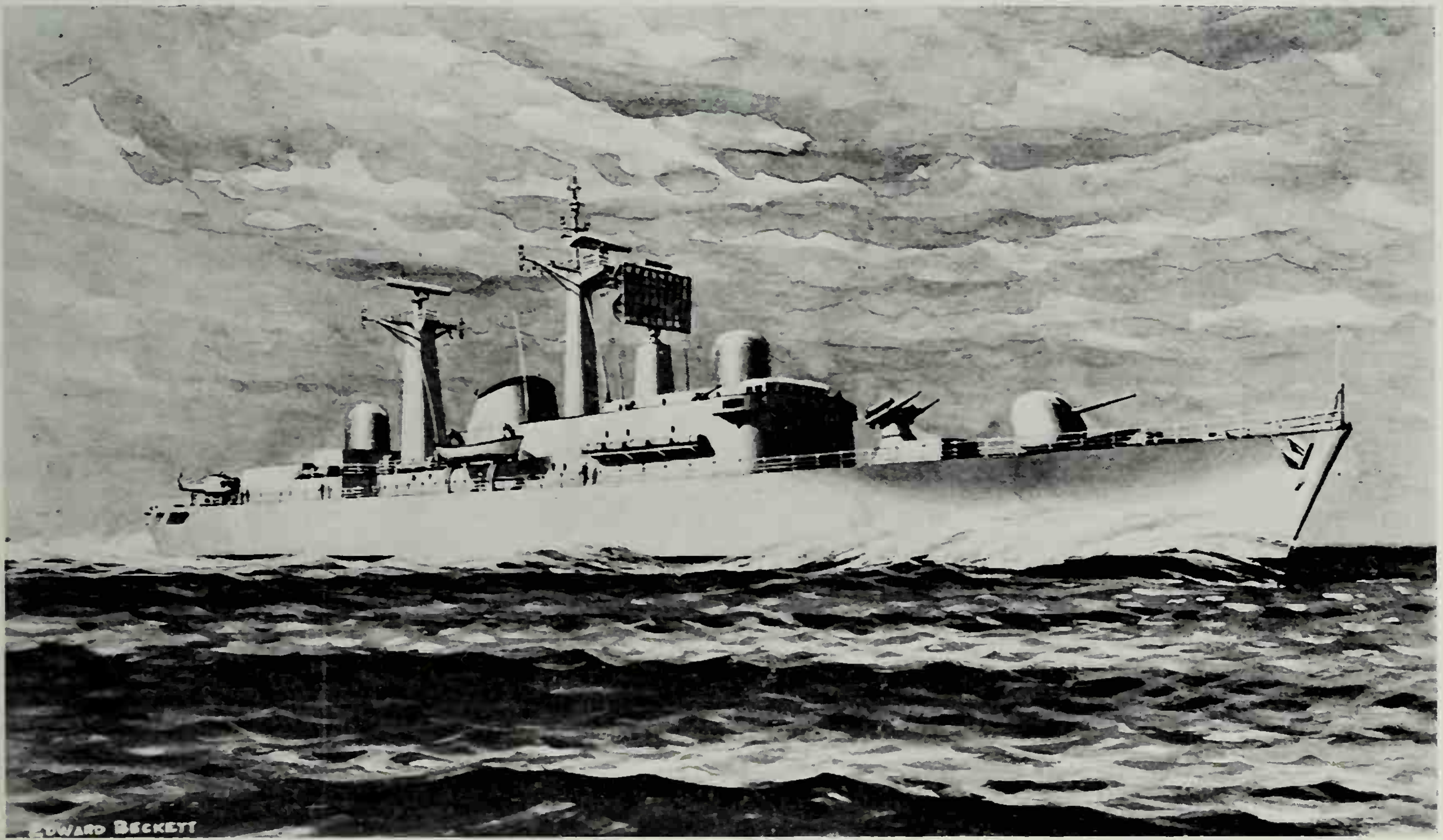
In addition to radar equipment, the company's naval systems capability is enhanced by the control engineering department. This department has specialised in servo equipment for weapons for over 30 years and at present has contracts for the remote power control systems for the Seawolf, Sea Dart and RN Ikara launchers, the 4·5-in Mk 8 gun mounting and the anti-submarine mortar Mk 10.

Control equipment

Many specialised sub-systems are also supplied by the company, including gyro and magnetometer degaussing schemes, cathodic protection equipment, temperature scanners and static inverters which power several sub-systems.

The company has developed a new standard automatic voltage regulator, the Mk 100 VR Series, in conjunction with the British Ministry of Defence (Navy); this is described elsewhere in this Catalogue.

The various activities within the company are co-ordinated by the systems engineering department to provide a naval systems capability embracing radar, electronic and control systems, utilising the extensive development, design and manufacturing services of Marconi Radar Systems Limited.



Artist's impression of the Type 42 destroyer (photo by courtesy of Vickers Ltd)

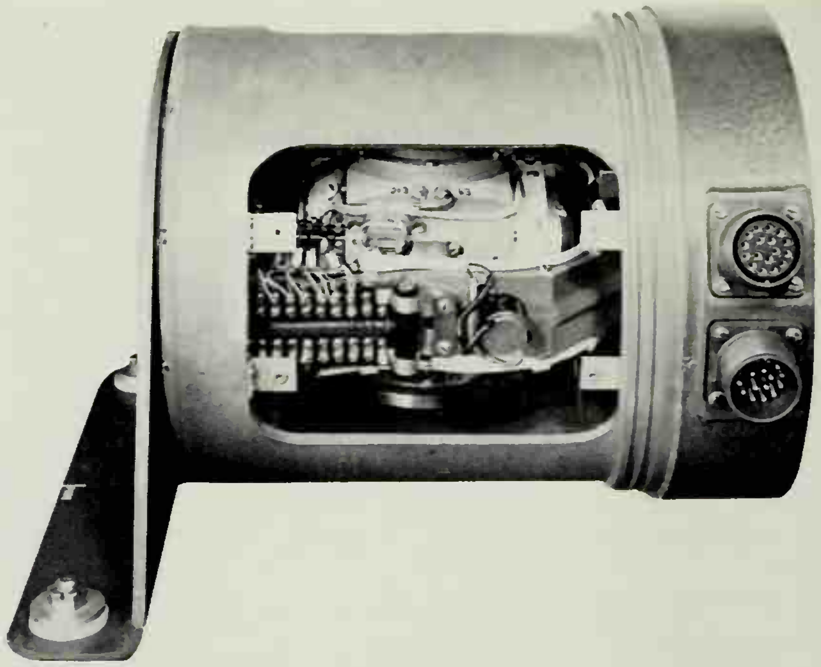
A GEC-Marconi Electronics Company
MARCONI RADAR SYSTEMS LIMITED
New Parks, Leicester, LE3 1UF, England
Telephone: Leicester 871331 Cables: Assocelect Leicester Telex: 34551

Vertical reference gyro Mk 20

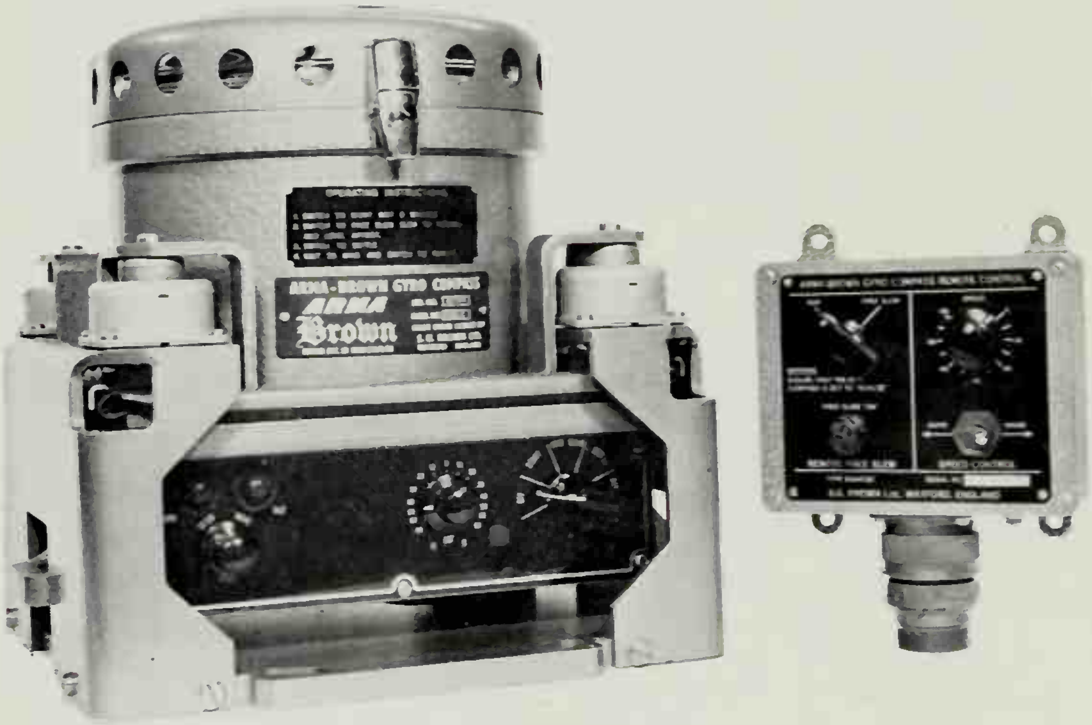
The Arma-Brown vertical reference gyro Mk 20 is a stable element which is smaller than many earlier types of instruments of this class. It consists of a gyro platform controlled by a single two-axis floated gyroscope placed with the spin axis vertical. The gyro is normally slaved to the vertical by means of a pair of damped pendulum units. By using a computer to correct the platform for errors due to the ship's motion and earth's rotation, the system yields a basic accuracy of ±3 minutes of arc. The degree of sophistication that is incorporated in the computer depends on the requirements of the particular application, notably the maximum speed of the ship in which it is to be used.

The Mk 20 gyro and computer are in service, and are used in conjunction with an Arma-Brown gyro compass to provide an integrated heading and vertical reference system for navigation and weapons fire control stabilisation.

The gyro reference unit occupies approximately 5000 cm³ (300 in³) and weighs approximately 13·6 kg (30 lb). The associated computer occupies approximately 6500 cm³ (400 in³) and weighs approximately 13·6 kg (30 lb).



The Arma-Brown vertical reference gyro Mk 20 for navigation and fire control



Arma-Brown gyro compass Mk 1 Mod 5

The Arma-Brown gyro compass (Mk 1 Mod 5) has a separate control box that enables the directional gyro mode and speed compensation controls to be selected remotely from the compass.

These facilities are particularly advantageous in maintaining compass accuracy in fighting ships during high-speed manoeuvres.

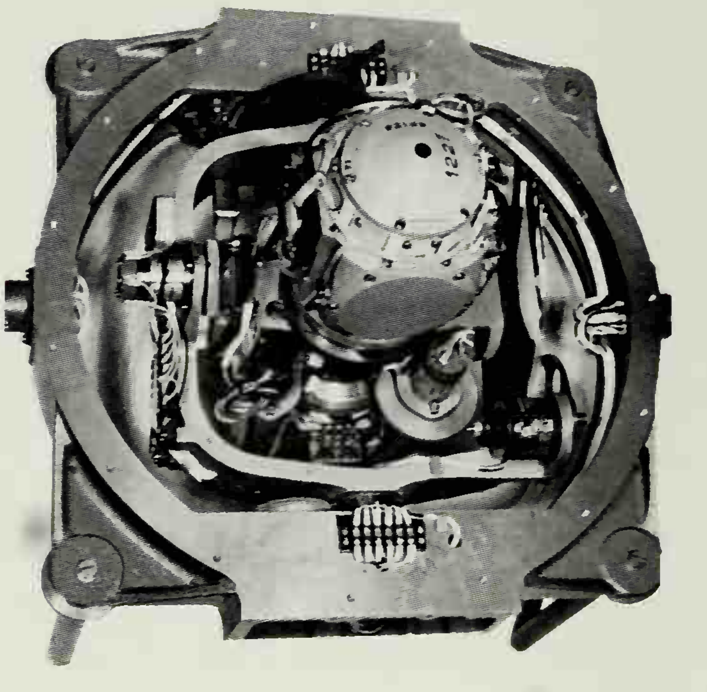
Left: the Arma-Brown gyro compass Mk 1 Mod 5 with remote control unit

Three-axis stable platform Mk 30

The Arma-Brown three-axis stable platform Mk 30 is a compact three-axis general-purpose reference system giving roll, pitch and heading information which meet the needs of all ship's equipment requiring a stable reference for fire control and kindred applications. This reference system uses good-quality floated gyroscopes of the same type as that produced by the company in large quantities for its gyro reference systems and can therefore be regarded as already proven for marine application. Provision is made for the unit to operate either in the gyro-compassing mode or directional gyro mode, as required, and hence it is possible to use the reference system to replace all vertical and directional gyroscopes at present found in a ship, other than those provided specifically for a ship's inertial system. The system yields a basic accuracy of 3 minutes of arc to the vertical and 6 minutes of arc to true north.

The platform unit occupies approximately 0·0424 m³ (2·5 ft³) and weighs approximately 23 kg (50 lb); the associated computer and power supply occupy a further 0·0566 m³ (2 ft³), and weigh approximately 16 kg (35 lb).

Below: the Arma-Brown three-axis stable platform Mk 30 gives roll, pitch and heading information



Gyro reference system

for ship's navigation and weapons control

Arma-Brown gyro compass

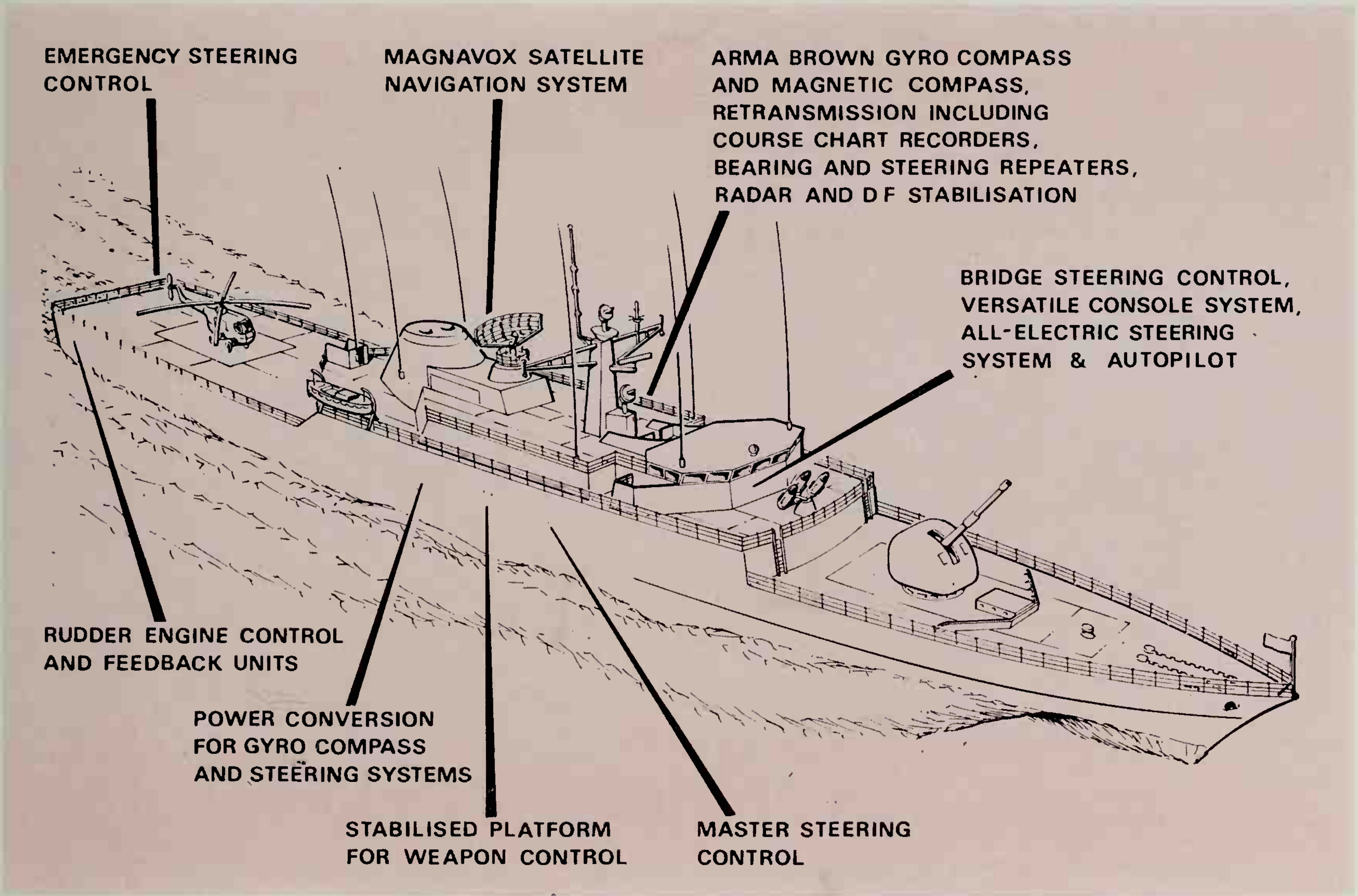
The Arma-Brown gyro compass is suitable for use in naval vessels of all types for speeds up to 60 knots. It provides a true north reference in the form of a visual indication on a card in the compass unit, and remotely by means of synchro transmitters which can operate heading indicators or a variety of other equipment, either directly or through an external retransmission unit.

Unlimited azimuth reference outputs can be provided for such duties as navigation, weapon alignment, radar stabilisation and automatic steering control.

The master compass is little larger than a standard steering repeater and as such can easily be incorporated into any vessel's layout, offering maximum utilisation of available space.

Power converters enable the compass system to be operated from virtually any ships main supply from 24 V upwards. The measured magnetic signature of the gyro compass is within the limits laid down for special applications in the Royal Navy.

The Arma-Brown compass system has been proven by its extensive use in naval ships of 30 nationalities. Minimum shipboard maintenance is necessary; the gyro unit has a mean-time-between-failure record in excess of 25 000 hours.


EMERGENCY STEERING CONTROL
MAGNAVOX SATELLITE NAVIGATION SYSTEM
ARMA BROWN GYRO COMPASS AND MAGNETIC COMPASS, RETRANSMISSION INCLUDING COURSE CHART RECORDERS, BEARING AND STEERING REPEATERS, RADAR AND D F STABILISATION
BRIDGE STEERING CONTROL, VERSATILE CONSOLE SYSTEM, ALL-ELECTRIC STEERING SYSTEM & AUTOPILOT
RUDDER ENGINE CONTROL AND FEEDBACK UNITS
POWER CONVERSION FOR GYRO COMPASS AND STEERING SYSTEMS
STABILISED PLATFORM FOR WEAPON CONTROL
MASTER STEERING CONTROL

Typical reference and associated control equipments supplied for use in naval vessels

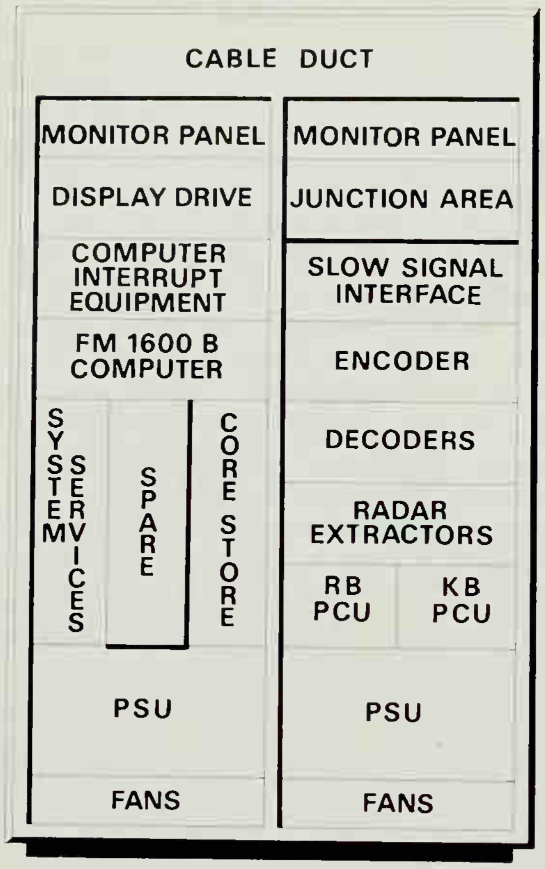
Specification

Settling point error: normal ±0·25°
Turntable: ±0·5°
Small angle Scorsby: total spread 1·5°
Large angle Scorsby: total spread 2·0°
Damping (run mode): 50% to 65% at period 120 minutes
Correction for speed: manual or automatic to 60 knots
Effect of magnetic fields: effectively nil
Angular freedom: ±50° in pitch and roll axes
Temperature (operating): –10° to +50°C

Humidity: 95% RH
Shock: 16 g
Vibration: maximum error ±1·5
Radio interference: none
Follow-up rate: 100° per second (limiting rate before toppling 140°/second)
Latitude range: 80° north to 80° south as gyro compass; no limit as directional gyro
All the above parameters meet or are better than spec MIL-C-15952F (Ships)

A Hawker Siddeley Company

S G BROWN LIMITED
Greycaine Road, Watford, Hertfordshire, WD2 4XU, England
Telephone: Watford 27241 Cables: Sidbrownix Watford Telex: 23408


CABLE DUCT
MONITOR PANEL
DISPLAY DRIVE
COMPUTER INTERRUPT EQUIPMENT
FM 1600 B COMPUTER
SYSTEM
SERVICES
SPARE
CORE STORE
PSU
FANS
MONITOR PANEL
JUNCTION AREA
SLOW SIGNAL INTERFACE
ENCODER
DECODERS
RADAR EXTRACTORS
RB PCU
KB PCU
PSU
FANS

CAAIS digital equipment is designed on a modular principle, offering considerable flexibility in the creation of systems for a wide variety of vessels. Illustrated is a typical cabinet arrangement for an ASW frigate, incorporating a Ferranti FM1600B microminiature computer

CAAIS

Computer-assisted action information system

CAAIS (Computer-Assisted Action Information System) is the latest of a series of digital data-handling systems using Ferranti computers and equipment to be ordered by the Royal Navy. It is intended for fitting in frigates and smaller craft, for both new construction and subsequent fitting.

The system has been specifically designed for small ship applications, with the primary aim of enhancing the performance of human operators by computer-assistance in appropriate areas. It is adaptable on a modular basis to suit the requirements of different classes of ship.

CAAIS provides many features normally found only in much bigger systems, such as:

Interlaced raw radar and computer-generated display picture
Automatic tracking of air and surface radar targets
Semi-automatic input of sonar and other data
Digital data-link operation
Target designation to weapon systems
Special aids for anti-submarine and surface operations.

With all this, CAAIS has been designed to a cost low enough to permit widespread fitting. This has been achieved by careful selection of operational requirements to give maximum cost-effectiveness, by the use of extremely economical Deccascan displays (which none the less provide all the essential features for this type of operation) and by the use of the highly efficient Ferranti FM1600B digital computer and the modular range of fully compatible associated units. These have been developed especially for naval systems and permit the adaptation of CAAIS to the widest range of ship applications.

Specification

The digital equipment modules for CAAIS are housed in two standard cabinets, each having its own power supply unit and fan cooling. Main power (approximately 2 kVA at 200 V 400 Hz) is required from a regulated supply. The cassette-loaded tape reader and tape punch (with spooling take-up unit) are mounted separately, as is the data-link terminal equipment.

Dimensions of a two-cabinet suite are 117 cm by 57 cm by 198 cm high (including shock mounts) and the total weight of the digital equipment is 500 kg.

Each shelf module houses a number of withdrawable six-layer printed-circuit logic panels, on which are mounted Ferranti Micronor 2 micro-circuit elements. The panels plug into 12-layer printed circuit backboards. For system variation, extra modules may be added, or some units omitted; the input/output units are themselves modular, the number of panels fitted being adjusted to requirements. The principal units are:

FM1600B computer (central processor): 24-bit parallel mode computer, operating at a clock rate of 3 MHz. Three-address, indirect addressing instruction code.

Core store: Typically 16 384 words of Ferranti 650 nanosecond core store; additional store modules may be added to a total of 65 536 words.

Computer interrupt equipment: Controls input/output of data via standard interfaces, and regulates interrupt priority.

System services: Include alarm logic, real-time clock, and control logic and power supply unit for tape reader and punch.

Display drive unit: Provides synthetic character generation and positioning signals, synchronisation, 'interlace' and off-centring controls for up to six displays.

'Slow signal' interface: Provides multiplexed input and output control for single-bit (relay and switch) signals, up to a total of 144 incoming and 96 outgoing signals, as required.

Encoder unit: All-solid-state device providing multiplexed input control and analogue-to-digital conversion for up to 28 synchro-resolver channels.

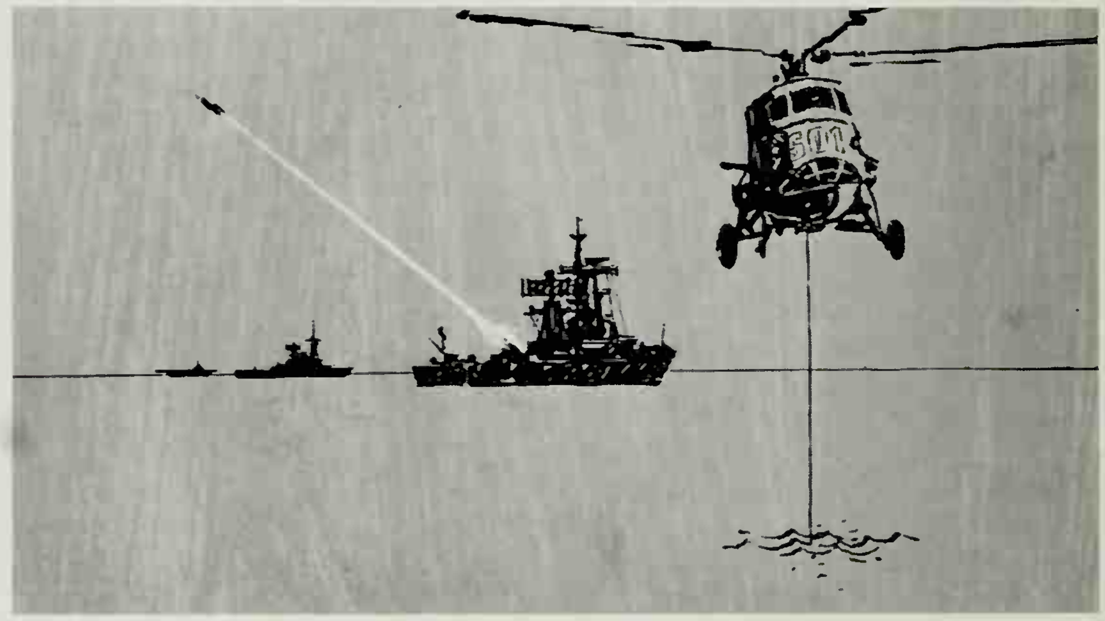
Decoder (stepper) unit: Provides synchro outputs, the synchros being driven by stepper motors under closed-loop control from the computer.

Radar extractors (LAX): Provide gating control, quantisation, and binary coding of radar video for processing in the computer.

Rolling ball and keyboard peripheral control units: Provide multiplexed input control for signals from up to 12 rolling ball and keyboard units respectively.

FERRANTI LIMITED
Digital Systems Department
Western Road, Bracknell, Berkshire, RG12 1RA, England
Telephone: Bracknell 3232 Telex: 84117

FERRANTI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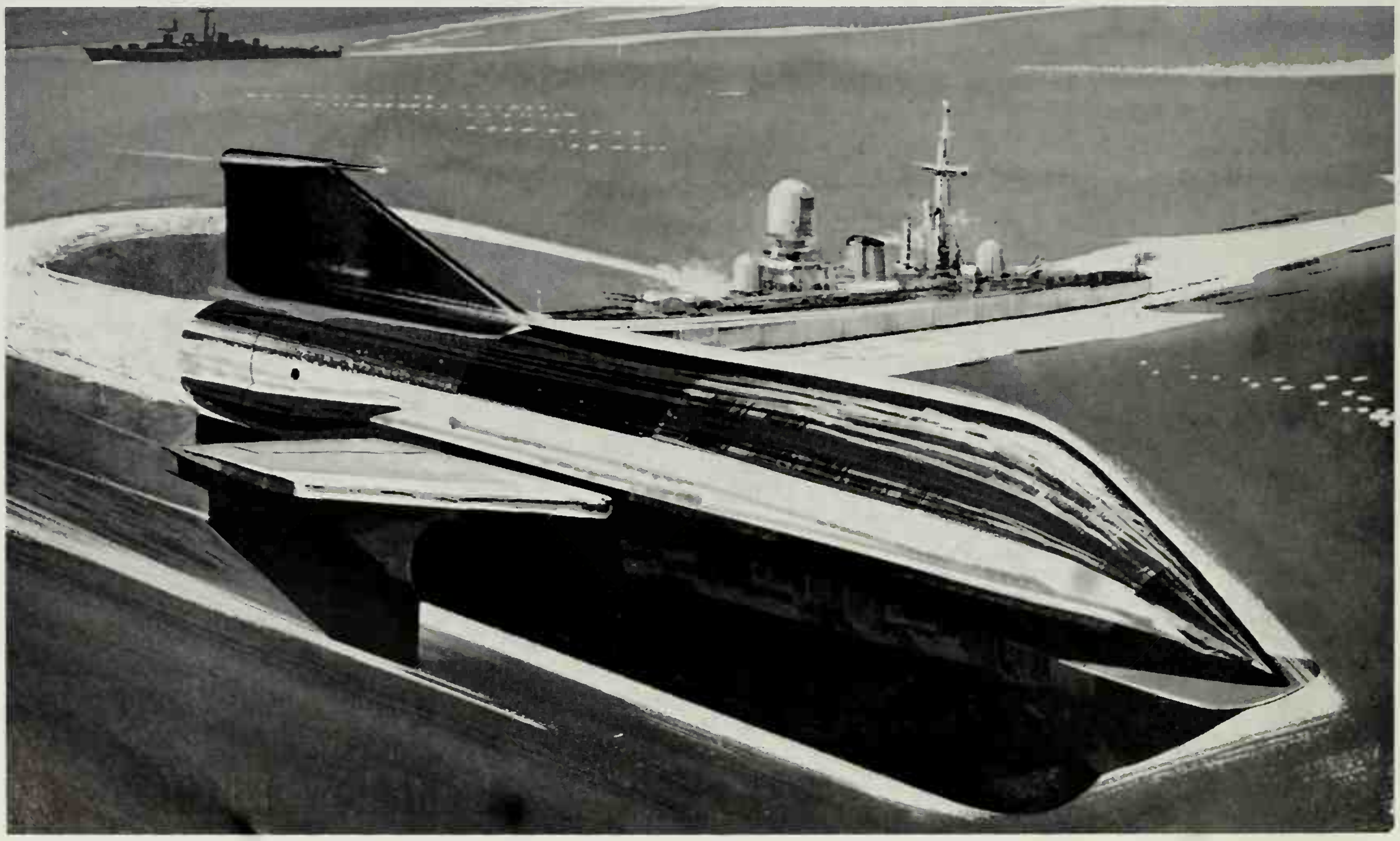

Weapon control system

Data-handling and weapon-control for naval use

In modern warfare, threats materialise and strike so quickly that it is physically impossible, without automatic assistance, for the commander to evaluate and retaliate rapidly enough to be effective. Thanks to the enormous range and variety of modern sensor equipment now available, the problem is further complicated by the sheer volume of information pouring into the command centre too quickly for human sorting and comprehension. Ferranti data-handling and weapon control systems provide the answer. Based on a range of sophisticated microminiature digital computers, Ferranti systems are capable of accepting automatically a mass of information from radars, sonars, passive equipment, data links, etc, of digesting, correlating, ordering and displaying information in clear, comprehensive form and, subject to command approval, of aiming, controlling and firing such weapons as guns, anti-aircraft or anti-submarine missiles, torpedoes, etc. Ferranti systems can also, if required, do much more, such as assembling messages for data links, controlling radars, forecasting or recommending actions and solving navigational problems.

Unique to Ferranti systems is the flexibility of operation offered—both in terms of the range of vessels in which they can be fitted either as original equipment or subsequently, and in the wide range of duties they can undertake.

At the heart of all Ferranti systems lies either the FM1600 or the FM1600B computer—the most advanced microminiature digital computers currently available. Ferranti has applied the same degree of sophistication to all the other modules vital to a complete, integrated system, such as modules for processing radar data, for encoding synchro outputs for weapon control, for operating data links and for generating information for display. These and many others are the 'building blocks' of Ferranti systems—easily and quickly assembled in different configurations to create a system exactly tailored to any type of vessel and any range of duties.

Having worked closely with the Royal Navy and other members of NATO, Ferranti has wide experience, technical ability and large-scale resources to provide data-handling and weapon control systems to meet specific service requirements, present or future.

Ferranti FM1600 computers are currently in service or on order for control of the following weapons:

Seadart
Seawolf
Seacat
IKARA
Guns
Torpedoes

and in various systems for the control of aircraft and helicopter operations.

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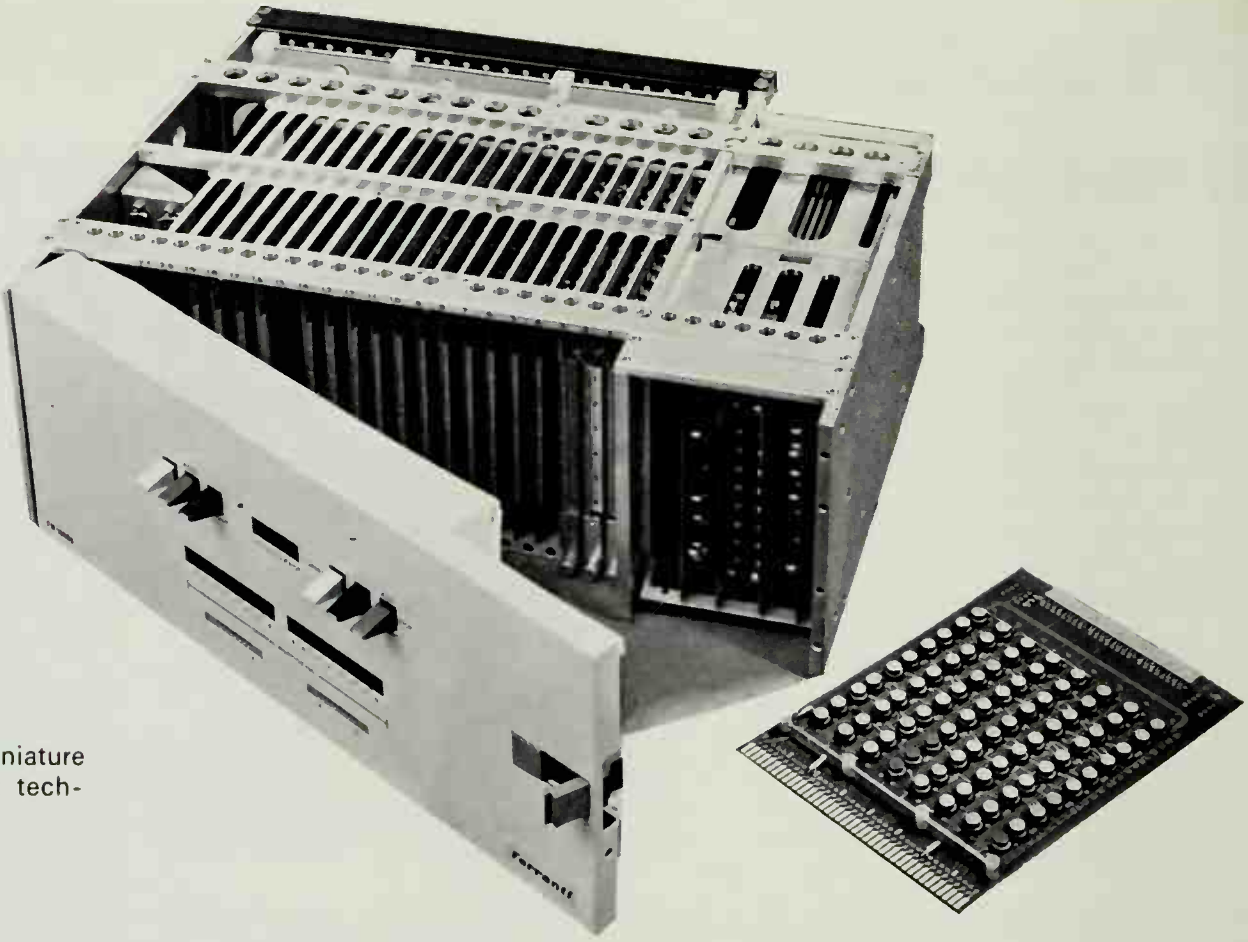
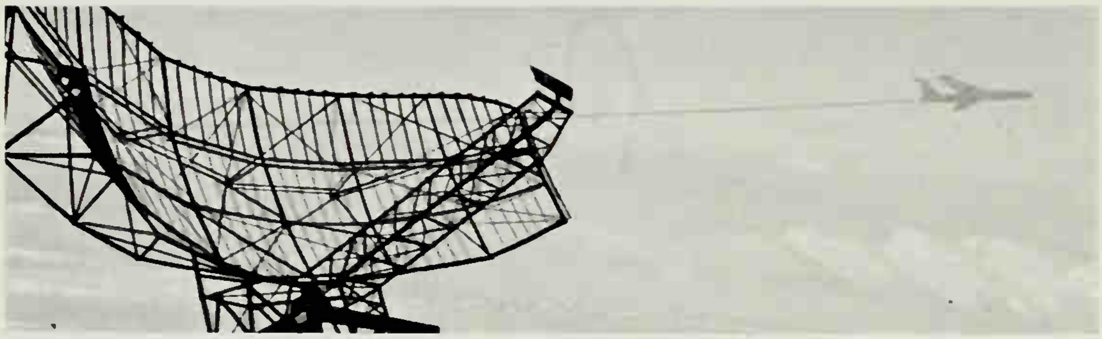


The Ferranti FM1600B microminiature computer incorporates the latest techniques in solid-state circuitry

'Poseidon' is an advanced parallel-mode computer designed for Ferranti action data automation (ADA) systems such as that installed in HMS *Eagle*

'Cerberus was specially designed as the central processor for the Ferranti 'Green Ginger' data processing system, which is used to control the operation of Thunderbird II missiles



'Apollo' is a general-purpose time-sharing computer oriented to handle operational control tasks. It is installed at the Control Centre of Prestwick Airport, to test the use of computers in handling air traffic

The FM1600 range of equipment is a development of 'Poseidon', using the latest solid-state integrated circuit devices. It is faster and offers improved input/output facilities. It is used in development and trials of 'Sea Dart' missiles

Digital data processor

Ferranti FM1600B microminiature computer

The Ferranti FM1600B is the latest and most advanced unit in a long line of military computers designed and made by Ferranti. These include Poseidon (now installed on the Royal Navy's aircraft carrier HMS *Eagle* to process action data), Apollo (used at Prestwick Airport in tests to validate the use of computers in air traffic control), Cerberus (which controls the operation of Thunderbird II missiles), the F1600 (employed in the development of Sea Dart missiles), and the FM1600.

All these equipments have proved highly successful in their tasks and have led computer technology in their respective fields.

The FM1600B is the basic unit of the latest range of Ferranti real-time military computer systems. Its outstanding feature is its compactness: with half the power of its immediate predecessor, the FM1600, it occupies only one-fifth of the space, thus offering considerable space savings for an equivalent data-handling capacity.

The FM1600B is the central processor of a complete range of modular electronic data processing units capable of handling the inputs and outputs of naval data handling and weapon control systems, air defence systems, message switching systems and air traffic control systems, as well as the requirements of a wide range of trainers and simulators. The equipment is also suitable for use in computer programme development centres.

Specification

The Ferranti FM1600B unit is a single-shelf module comprising the central processor, one 4096-word block of 1μsec core store, drive and selection circuits. The complete module measures only 483 × 408 × 178mm (19 × 16 × 7in) and weighs 18kg (40lb).

The central processor comprises 19 six-layer printed circuit panels carrying a total of 1300 Ferranti integrated circuit devices. These logic circuit panels plug into a twelve-layer printed circuit backboard.

The basic core store of 4096 words can be expanded to a total capacity of 63 536 words. The word format is of the 24-bit, twos complement type.

The operating mode of the system is parallel. The clock rate is 3MHz. Both fixed point and floating point arithmetic is used.

The Ferranti FM1600B equipment fully conforms to British and NATO specifications for electronic data handling equipment.

Now in production for:

- Seawolf control
- CAAIS
- Gun/Seacat control
- Data handling for submarines
- Radar simulators
- Admiralty Research Laboratories
- SHAPE Technical Centre
- LEOK
- Trainers
- Universities

FERRANTI LIMITED
Digital Systems Department
Western Road, Bracknell, Berkshire, RG12 1RA, England
Telephone: Bracknell 3232 Telex: 84117

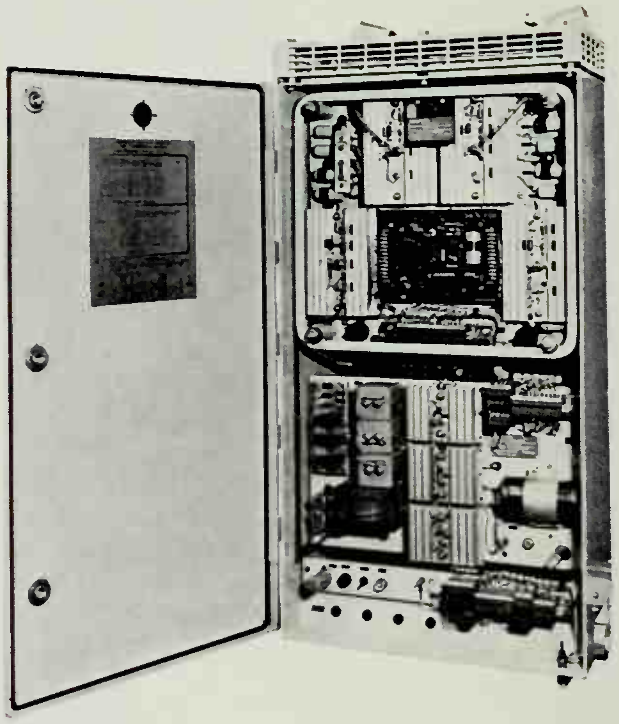
FERRANTI

Static frequency changers

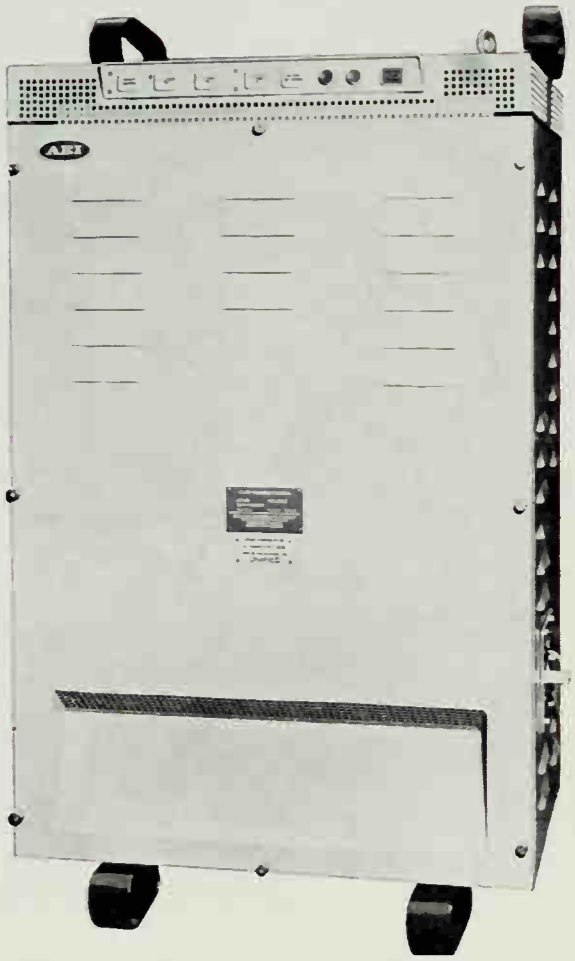
The company is also responsible for the design, in co-operation with the British Ministry of Defence (Navy), production and installation of a range of static frequency changers and power inverters for various ship's electrical systems.

Brief details of standard units are given here; enquiries for these or for special units to serve individual requirements are welcome.

Left: the Mk 1 SFC is a no-break static frequency changer of 80 W mean capacity, and up to 120 W peak for short periods. Designed to British Ministry of Defence (Navy) specifications, the unit converts an input of 115 V, single-phase, 50/60 Hz into an output of 115 V, single-phase, 60 Hz. Protection against supply failure is provided by a float-charged 24 V battery, which can maintain a continuous output for up to 30 minutes. The unit is inherently short-circuit-proof.

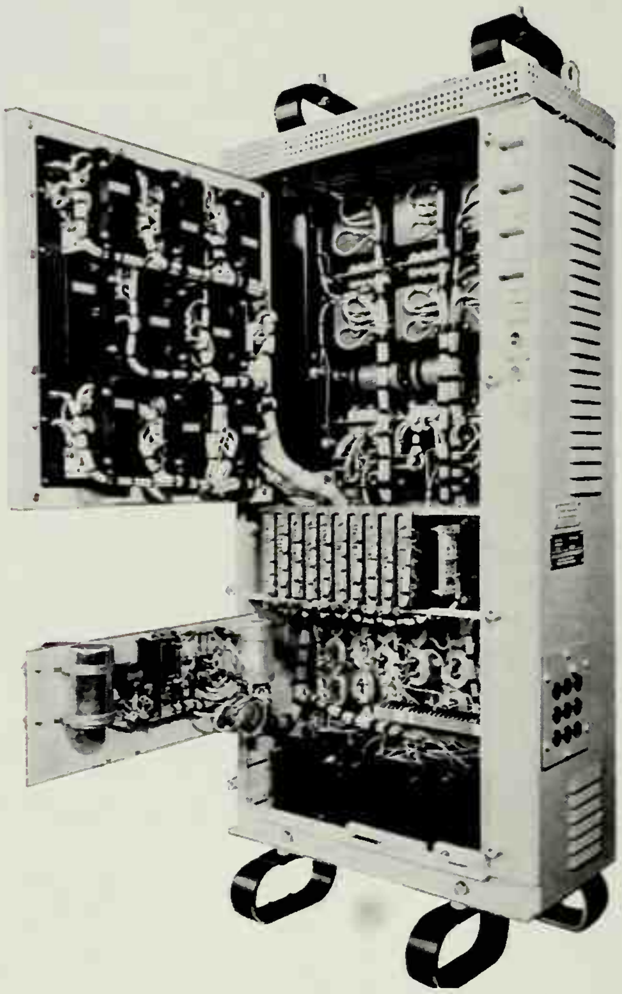


Right: the Mk 4 SFC is a static frequency changer of 1 kVA capacity. Designed to MOD (Navy) specifications, the unit produces a 115 V, single phase, 400 Hz output from a 400 V, three-phase, 60 Hz input. The unit is short-circuit-proof, with an overall efficiency of approximately 70 per cent and a total harmonic distortion of less than 5 per cent.



The Mk 3 SFC is a convection-cooled, no-break static frequency converter of 2 kVA capacity. Designed to MOD (Navy) specifications, the unit converts an input of 440 V, 50 or 60 Hz, three-phase into 115 V, 400 Hz, single and three-phase outputs. Local remote control and indication facilities are available.

Protection against supply failure is provided by a float-charged 140 V (nominal) battery supply in a separate cabinet, which can maintain the output for up to 30 minutes. Trips are incorporated as a precaution against incorrect frequency and voltage outputs, and the battery charging current is monitored.



The Mk 5 SPI is a static power inverter designed to MOD (Navy) specifications for submarines. The unit converts a dc input of 170–320 V to two 115 V, 400 Hz outputs of 1 kVA (three-phase) and 400 VA (single-phase) capacity. Local and remote control and indication facilities are provided and the unit is naturally cooled. Trips are employed as protection from incorrect frequency and voltage outputs.

Naval control equipment

Power servos and thyristor control systems

Power servos

The AEI Control Engineering Department of Marconi Radar Systems Ltd has been associated with naval servo systems since the 1930s, and today designs and manufactures the remote power-control systems for the launchers and mountings of the Royal Navy's most modern weapon systems, including

Sea Dart
Seawolf
RN Ikara
4·5 in Mk 8 gun
A/S mortar Mk 10

Using the latest techniques of semiconductor technology, world-wide experience in this field is offered, and enquiries are invited for the design and development of power servo systems for launchers, mountings and aerial turning gear.

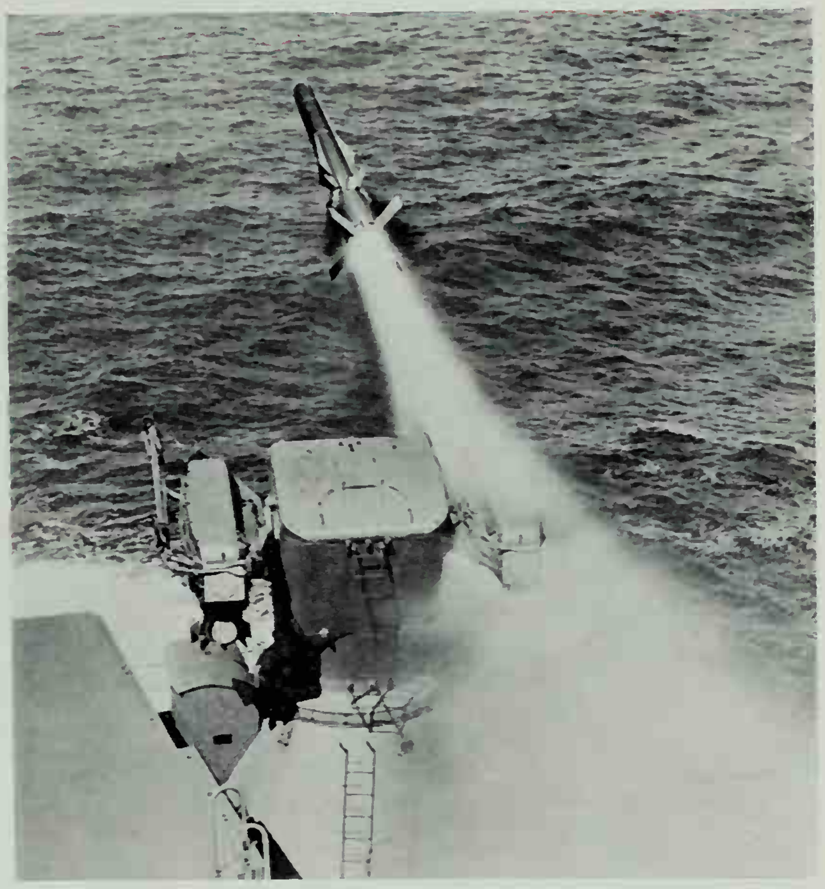
Automatic voltage regulators

AEI Control Engineering has, in conjunction with the British Ministry of Defence (Navy), developed a standard automatic voltage regulator known as the Mk 100 VR Series, which is suitable for conventional or brushless main and auxiliary generators. The advantage of this standardisation is that logistics problems are much simplified because the Mk 100 VR Series can be used with different types of generator on one ship—a facility not available before. The Mk 100 VR is made up of a standard basic tray or sub-assembly on which the circuits common to all generators are mounted. Different units may be selected from a range of sub-units and easily attached to the basic tray to meet the specific generator requirements. This versatility means that the Mk 100 VR is suitable for operation with generator outputs of 117, 205, or 450 V and at frequencies of 60 or 400 Hz three-phase.

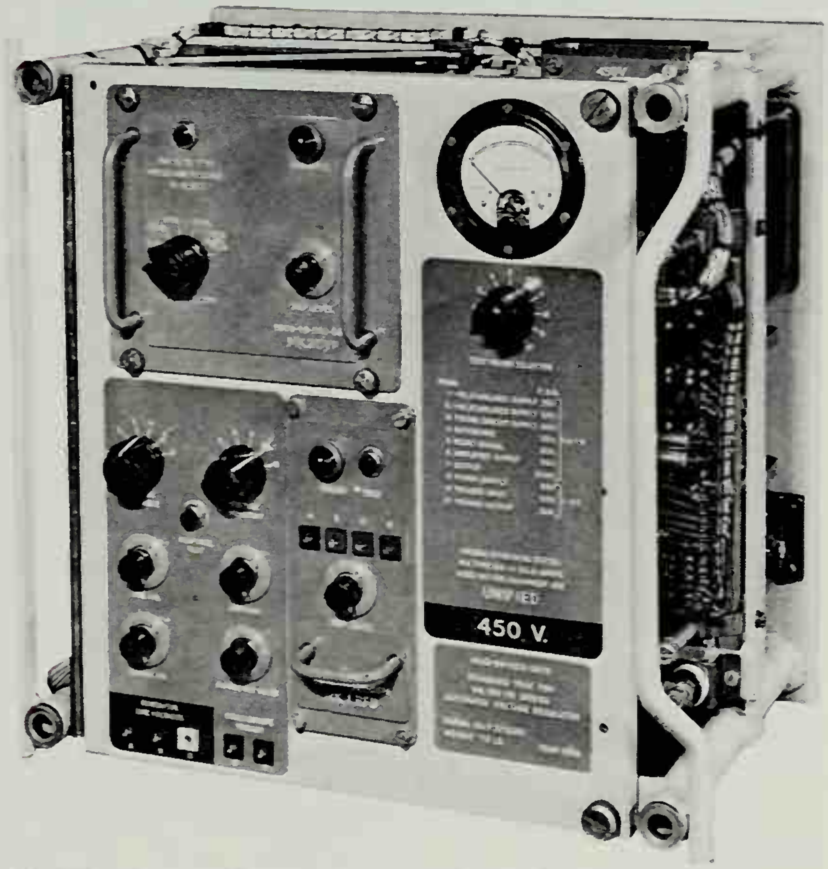
Other products

In addition to the equipments shown on these two pages, the AEI Control Engineering Department can also offer thyristor motor-control systems, degaussing equipment, cathodic protection equipment which is marketed jointly with Morgan Berkeley, three-term control systems, motor thermal protection units and several other items of control equipment including Standard Admiralty Modules.

The cathodic protection equipment, a standard equipment for the Royal Navy, has recently been redesigned and new design techniques have reduced the equipment cost, size and weight by more than half.



Sea Dart missile launch



Mk 100 VR Series automatic voltage regulator

A GEC-Marconi Electronics Company
MARCONI RADAR SYSTEMS LIMITED
AEI Control Engineering Department
New Parks, Leicester, LE3 1UF, England
Telephone: Leicester 871331 Cables: Assocelect Leicester Telex: 34551

Systems management

General-purpose processor suitable for military systems

Missile systems: hydraulic and electric actuation; autopilot; computer systems

Gunfire control: large and small ship systems

Radar: electronic scanning; circular polarisation; conventional parabolic systems

Ship inertial navigation systems (SINS): suitable for surface and underwater vessels to establish their exact position without external reference

Automatic check-out equipment

Gyro-compass systems: for surface vessels, submarines, fast patrol craft and amphibious vehicles

Ship stabilisation: activated fin and tank stabilisation for all types of vessels; list control systems are also available

Digital data handling

Memory storage: fixed and floating-head magnetic drum systems are available

Torpedo systems: electric and hydraulic actuation; sensors; attitude control systems

Mine counter-measure equipment

Sea-bed vehicle navigation: based on the Sperry land vehicle navigation system

Naval control systems

Hardware, software and systems management

A wide range of control equipment and systems, complete with systems management back-up, has been developed for naval purposes. Some examples of cost-effective Sperry systems are briefly described:

Hydraulic actuation

A lightweight, rapid-response/high-torque actuation system has been designed primarily for missiles and torpedoes. Three versions are offered:

(1) a conventional system employing a separate gas generator to power a hydraulic ring main.
(2) An advanced system employing iso-propyl nitrate both as a power source and as the hydraulic medium, whose principal advantages are improvements in weight, packing density and cost-effectiveness.
(3) An on-line hot-gas system, using hot gas at up to 1100°C, fed directly to the actuator.

Electric actuation

A lightweight, low-cost system designed especially for applications in the medium-torque range, typically for torpedoes and small missiles. Power take-off is either from a propeller shaft or separate electric motor. The system is offered either as a single module, or in multiples as a package.

Gyros

A wide range of gyros is offered for civil and military use. A typical example for a weapons application is a two-axis unit which has a free drift rate of better than 1° an hour, with a run-up time of 20 seconds. The instrument is packaged in a 152 mm (6 in) diameter sphere.

Safety and arming devices

Sperry are specialists in this field. A typical safety and arming unit comprises pressure-sensitive switches, g-sensitive switches and a mechanical double-integrating accelerometer.

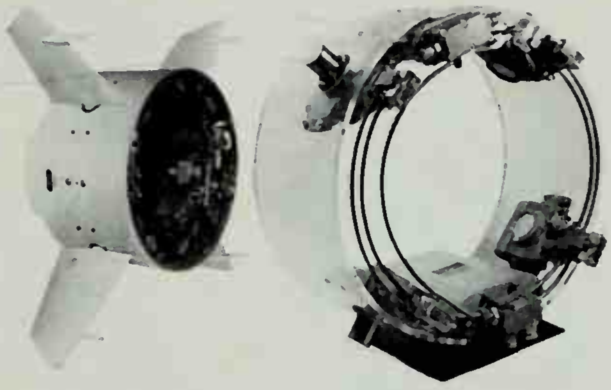
Electronic data processing

To match Sperry's capability in actuation systems, the Division has developed a strong electronics facility, the emphasis being on digital systems.

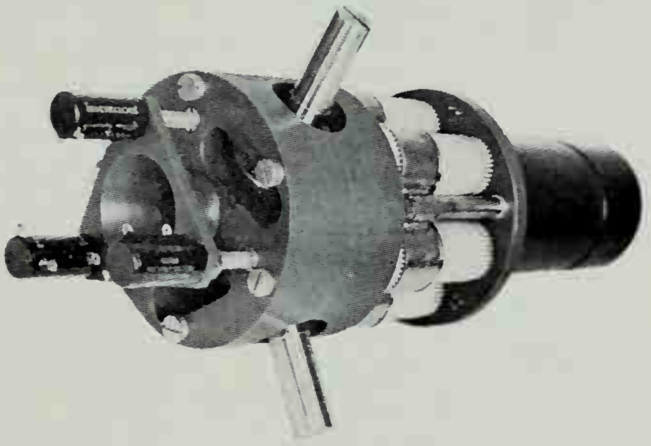
The Division has for a number of years supplied home and foreign navies with memory systems for tactical data handling. Fixed and floating-head units are available in capacities up to 8 Megabits.

Systems management

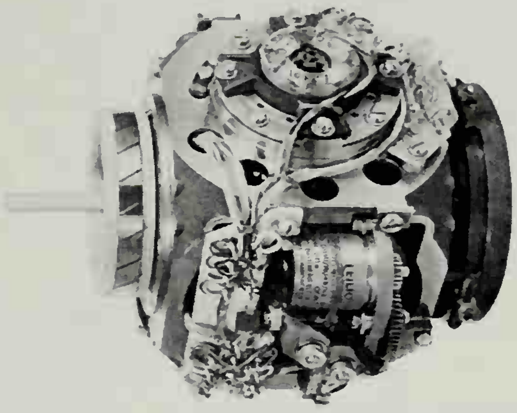
Sperry Gyroscope Division maintains a comprehensive systems management facility backed by simulator, computer, PERT and theoretical studies departments, whose tasks include the development of advanced integrated systems and subsequent systems management. Cost-effectiveness is the keynote of the operation.



Hydraulic actuation unit



Electric actuation unit



Two-axis missile gyro

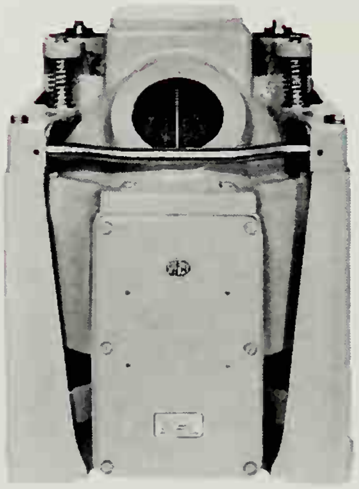
Floating-head memory store

SPERRY GYROSCOPE DIVISION
Sperry Rand Limited
Downshire Way, Bracknell, Berkshire, RG12 1QL, England
Telephone: Bracknell 3222 Cables: Sperigyco Bracknell Telex: 84129

SPERRY

Gyroscope systems

for marine navigation



Mk 23 gyro-compass system

The Sperry Mk 23 gyro compass is a small true-north-seeking compass designed specifically as standard equipment for surface vessels, submarines, fast patrol craft and amphibious vehicles, where reliability and accuracy under severe operating conditions are essential. It consists of a master unit and control panel, with additional alarm control, speed signal potentiometer (electro-magnetic log), one or more alarm bells, one or more annunciators and an isolating transformer as required.

The compass is compensated for speed error, latitude error and unbalance. It can operate as a directional gyro at high latitudes and has an electronic follow-up system which provides smooth accurate synchronous outputs of 1-1 and 36-1 speed/heading data which can be fed into a compass retransmission unit with either synchro outputs or stepping outputs to navigational and other systems' heading receivers.

Many naval vessels utilise dual Mk 23 compass systems, one for navigation, and the other for weapons; it is also fitted as a stand-by instrument in major warships using the Sperry Mk 19 gyro compass.

Specification

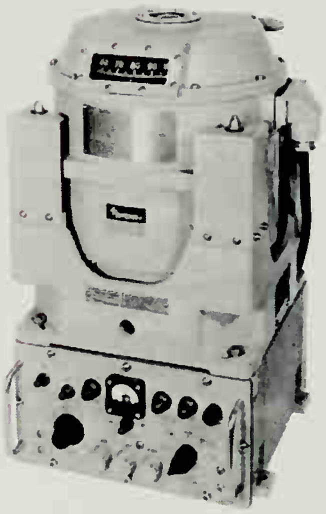
Settling repeatability: ±0·2deg

Accuracy in gyro compass mode: 90% accuracy ±0·5deg; maximum error ±0·75deg

Settling time from within ±5deg of settling point: 30min

Maximum drift as a directional gyro: 0·5deg/h for the first 2h

Maximum error in magnetic field of 10 gauss: ±1·5deg



Mk 27 gyro-compass system

The Sperry Mk 27 gyro compass is a new, low-cost, highly accurate heading reference specifically designed to meet the requirements of small military and commercial vessels. It complies with all military specifications for small-craft compasses.

The system requires only 0·057m^3 (2ft^3) of space and 50W of input power for operation. It provides a direct (conventional marine type) readout for installations employing the master compass at the steering station. The equipment can also be supplied with transmitters for compatibility with the Sperry gyro pilot automatic steering stand, radar, sonar and other systems requiring heading information.

The Mk 27 gyro compass equipment consists of two major components: the master compass and the electronics unit. For operation directly from the ship's 115V, 60–400Hz power supply, a power converter is also provided. Overall accuracy of the system is ±0·5 degrees. Mean time between failure on the gyro element is in excess of 20 000h.

Specification

Settling point error: ±0·5deg

Typical peak error at sea: ±1·5deg

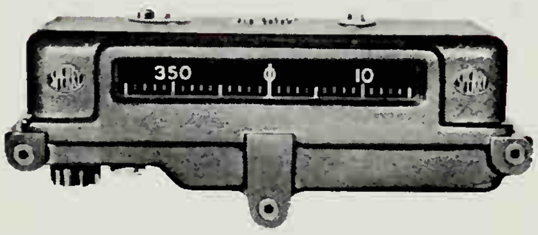
Roll and pitch clearance: ±45deg

Heading transmission system: (a) step transmission; (b) 1-speed or 1- and 36-speed synchro (either 60 or 400Hz)

Power requirements: 24V dc or 115V 60–400Hz with power converter

Starting power: 100W (5min)

Operating power: 50W



Tape-type heading indicator

Sperry tape-type heading indicators may be used either as heading indicators or steering repeaters and are specially designed for receiving master compass transmissions of the synchronous type. They are most suitable for the bridge, steering position, chartroom, captain's cabin and operations room.

Heading is shown by large graduations and figures viewed through a rectangular glass window, which is wide enough to display 15 degrees either side of the lubber line. Heading or rate of change of heading can easily be observed from one side of the bridge to the other. Accuracy is ±0·25 degree for synchro transmission and ±0·25 degree for step transmission relative to the master compass.

The instrument is fully weather-proofed and built to meet specification DEF 133 Section N2. The operating temperature range is from –10°C to +55°C. Backlighting is adjustable; red filters are fitted.

SPERRY GYROSCOPE DIVISION
Sperry Rand Limited
Downshire Way, Bracknell, Berkshire, RG12 1QL, England
Telephone: Bracknell 3222 Cables: Sperigyco Bracknell Telex: 84129

SPERRY

Charts
of sea lanes and coastal areas

For some years the Hydrographic Department of the Ministry of Defence has been considering a new style for the Admiralty Chart. The aims have been to improve its legibility and usefulness to the mariner, and to make increasing use of modern techniques to enable new information to be incorporated in the chart more speedily.

In addition, thought has been applied to the "metrication" of Admiralty Charts in view of the United Kingdom Government's declared policy to convert all measurements to metric units. This change should be of considerable benefit to many overseas users of Admiralty Charts who normally employ metric units.

The result has been that a new style chart has been adopted which will look radically different from former Admiralty Charts. Examples of the old and new styles are shown here.

The new style charts will show depths and heights in metres. New colours and style of lettering will be used and the result will be a general simplification and greater legibility.

The Hydrographic Department

The Hydrographic Department dates from 1795 when the Board of Admiralty appointed Mr Alexander Dalrymple, Hydrographer of the East India Company, as the first Hydrographer of the Navy. Before this, the collection of charts and hydrographic information was the responsibility of the individual ships' captains which proved a haphazard business. It resulted in more ships being lost by stranding and shipwreck than by enemy action. During the term of office of the second Hydrographer of the Navy, Captain T Hurd, RN, ships of the Royal Navy were getting the best charts available.

The present Hydrographer of the Navy, Rear Admiral G S Ritchie, CB, DSC, FRICS, is the nineteenth and all, with the exception of Mr Alexander Dalrymple, have been naval officers.

The Hydrographic Department now provides a comprehensive world-wide coverage of navigational charts and publications. Great Britain is one of the few countries which can provide this coverage. British Admiralty Charts are used the world over by all nationalities.

The primary concern of the Hydrographic Department is of course the needs of the Royal Navy, but consideration is also given to the needs of the British Merchant Service and foreign shipping. Apart from charts and publications supplied to the Royal Navy and United Kingdom Government Departments, the value of sales of charts at home and abroad last year was more than £800 000, nearly two thirds of which was for sales abroad.

The distribution of Admiralty Charts and hydrographic publications is made through appointed commercial agencies throughout the world, but further details and information are available from:

MINISTRY OF DEFENCE (NAVY)
The Hydrographic Department
Taunton, Somerset, England

Telephone: 0823–7900 Cables: Creechup Telex: 46274

Navigational computer

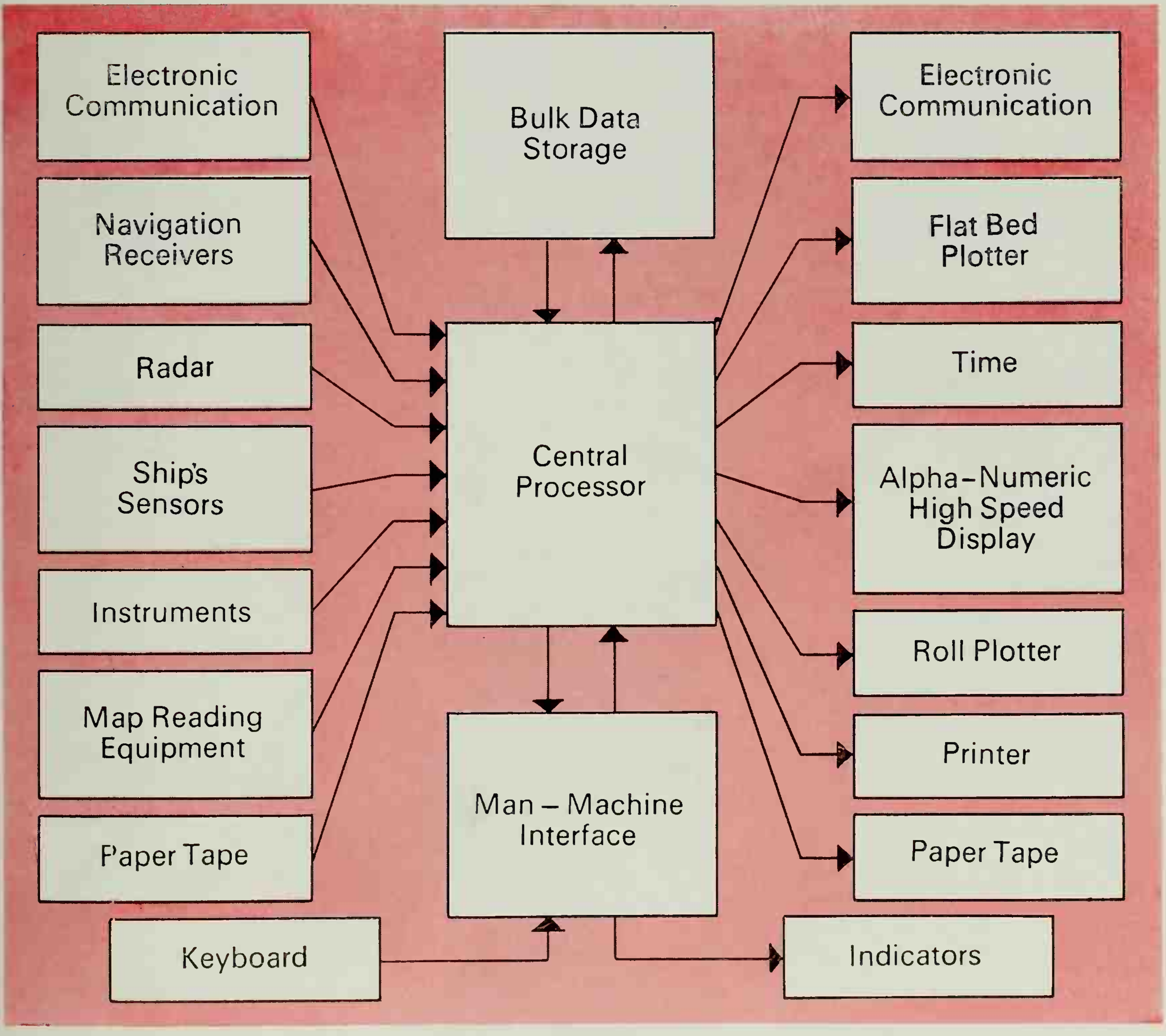
and other data-processing systems

The company is among the leading authorities on ways in which computers may be used in situations where a mass of data has to be collated, analysed and presented, as for instance in ship navigation and maritime research.

On-line real-time electronic data-processing systems are supplied that produce plots, graphs, charts and drawings in cartesian form from an input of positional data from any type of navigation aid and other measured or recorded parameters. The required forms of input and output vary widely among users. Each system is, therefore, likely to be unique but all are identified by the generic name of Hydroplot.

Hydroplot, which is particularly suitable for research and scientific applications, is installed on the ocean survey ships HMS *Hecate*, HMS *Hecla* and HMS *Hydra* as well as on the Fishery Research Vessel *Explorer*.

Great benefit may be derived by both naval and merchant vessels from using computer-based systems that can undertake many of the tasks associated with management, such as collision avoidance, satellite navigation, and weapon systems organisation. Commodore is a co-ordinated system which, using an on-line computer, handles both economically and effectively a ship's total requirements of this sort. By accepting inputs from such devices as radar, sonar, radio navigation aids and communication equipment, Commodore can provide assistance in navigation, ship handling, weather routeing, loading and other duties.


Electronic Communication
Navigation Receivers
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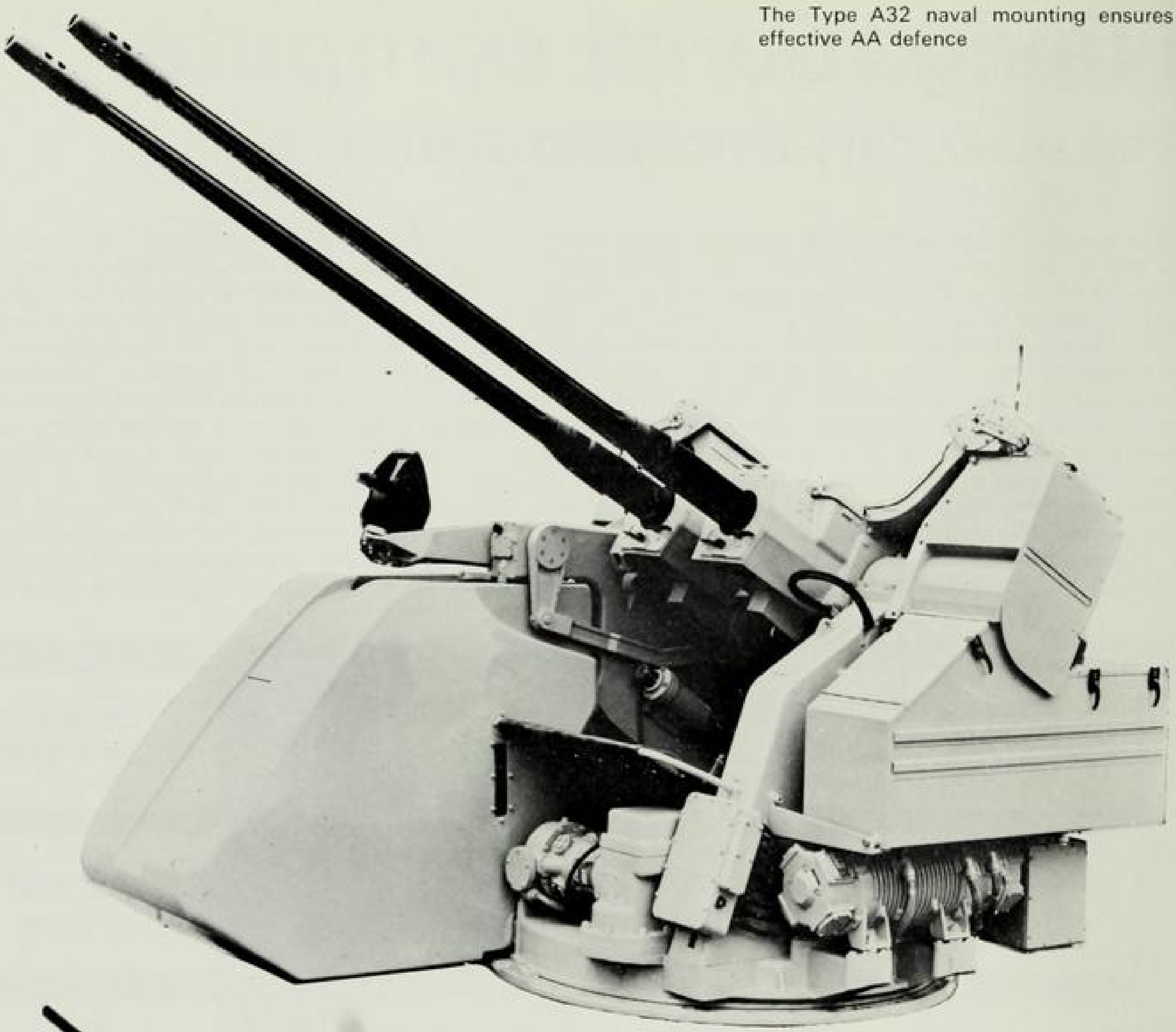
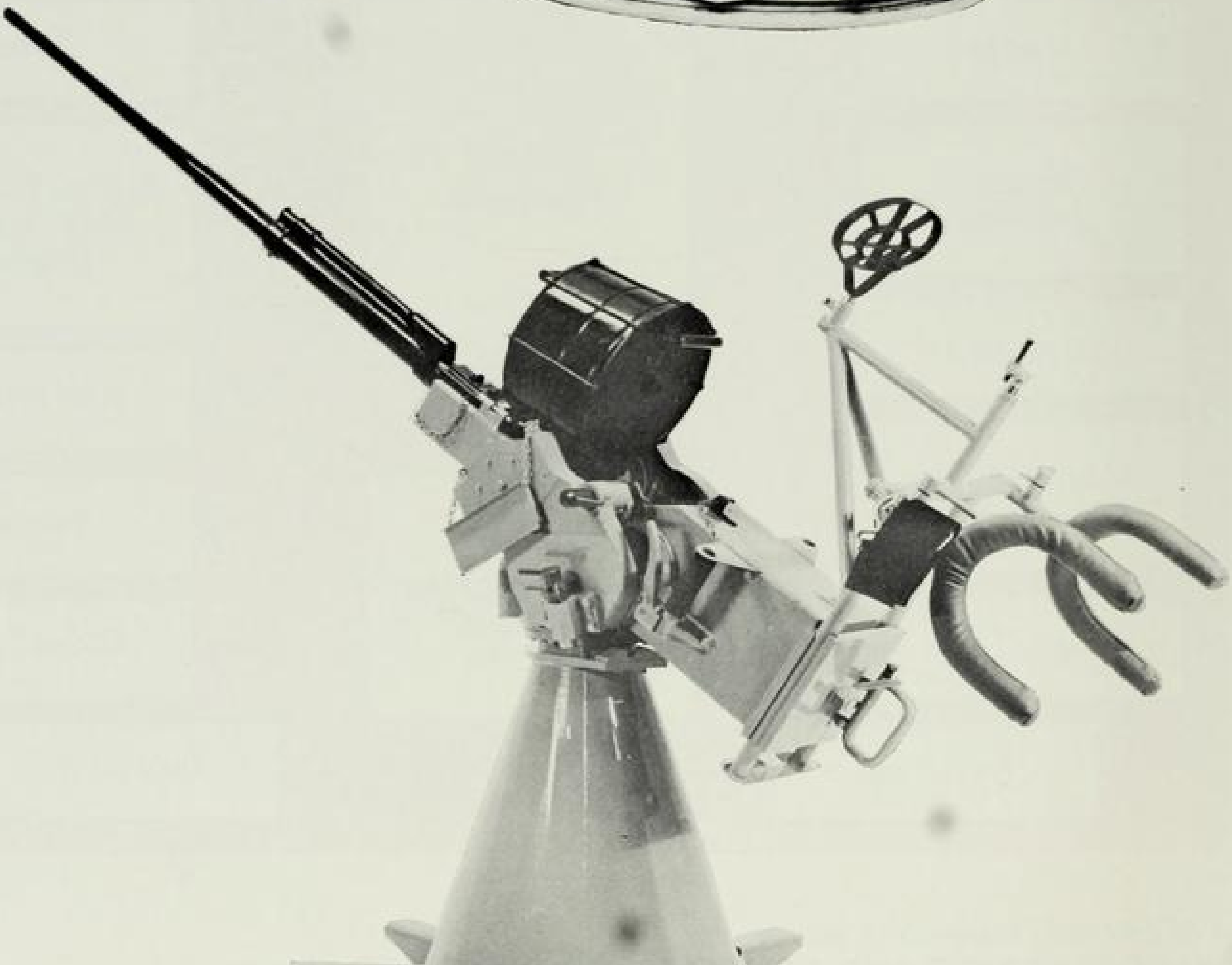
Electronic Communication
Flat Bed Plotter
Time
Alpha-Numeric High Speed Display
Roll Plotter
Printer
Paper Tape
Indicators

A GEC-Marconi Electronics Company
MARCONI SPACE AND DEFENCE SYSTEMS LTD
Naval Division
Chobham Road, Frimley, Camberley, Surrey, England
Telephone: Camberley 63311 Cables: Elliotauto Camberley Telex: 85289



The Type A32 naval mounting ensures effective AA defence



The Type A41 naval mounting provides a simple and inexpensive form of defence with minimum operator training

Gun mountings

for vessels of all types

Gyro-stabilised twin 30 mm gun mounting Type A32

The Type A32 mounting provides effective but inexpensive defence against very low-flying aircraft and missiles, together with a significant surface-to-surface role.

It can be used under local optical control when the gyro-stabilisation gives an excellent aiming capability even in the roughest seas. Coupled to a ship's fire control director it can also be used for remote operation.

The rapid rate of fire and control performance result in a high hit probability which, combined with the very low weight of the system, enables it to form either the main armament of modern high-speed patrol boats or the secondary weapon system in larger vessels.

Specification

Armament: twin 30 mm cannon Type 831L
Muzzle velocity: 1080 m/sec (3540 ft/sec)
Total rate of fire: 1300 rounds/min
Max effective AA range: 3000 m (3300 yd)
*Ammunition capacity: 320 rounds
Ammunition: details are given elsewhere in this Catalogue
Weight of mounting: 1642 kg (3612 lb)
(without ammunition and gunner)
Weight of 320 rounds: 320 kg (704 lb)
Traverse arc: unlimited

Elevation arc: +80° to −15°
Overall height: 1·46 m (4·80 ft)
Swept radius at 0° elevation: 2·52 m (8·25 ft)
Aiming control:
  Remote: fire director
  Local: two-motion controller with emergency manual drive
*Electrical power supply: 440 V 3-phase 60 Hz; 115 V single phase 400 Hz
*Gunsight: gyroscopic lead angle computing, Nife reflector or Delta IV

*Standard specifications may be altered to suit customers' special requirements

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Manually operated single 20 mm pedestal gun mounting Type A41

The A41 mounting is the simplest form of armament of the various types manufactured by BMARC.

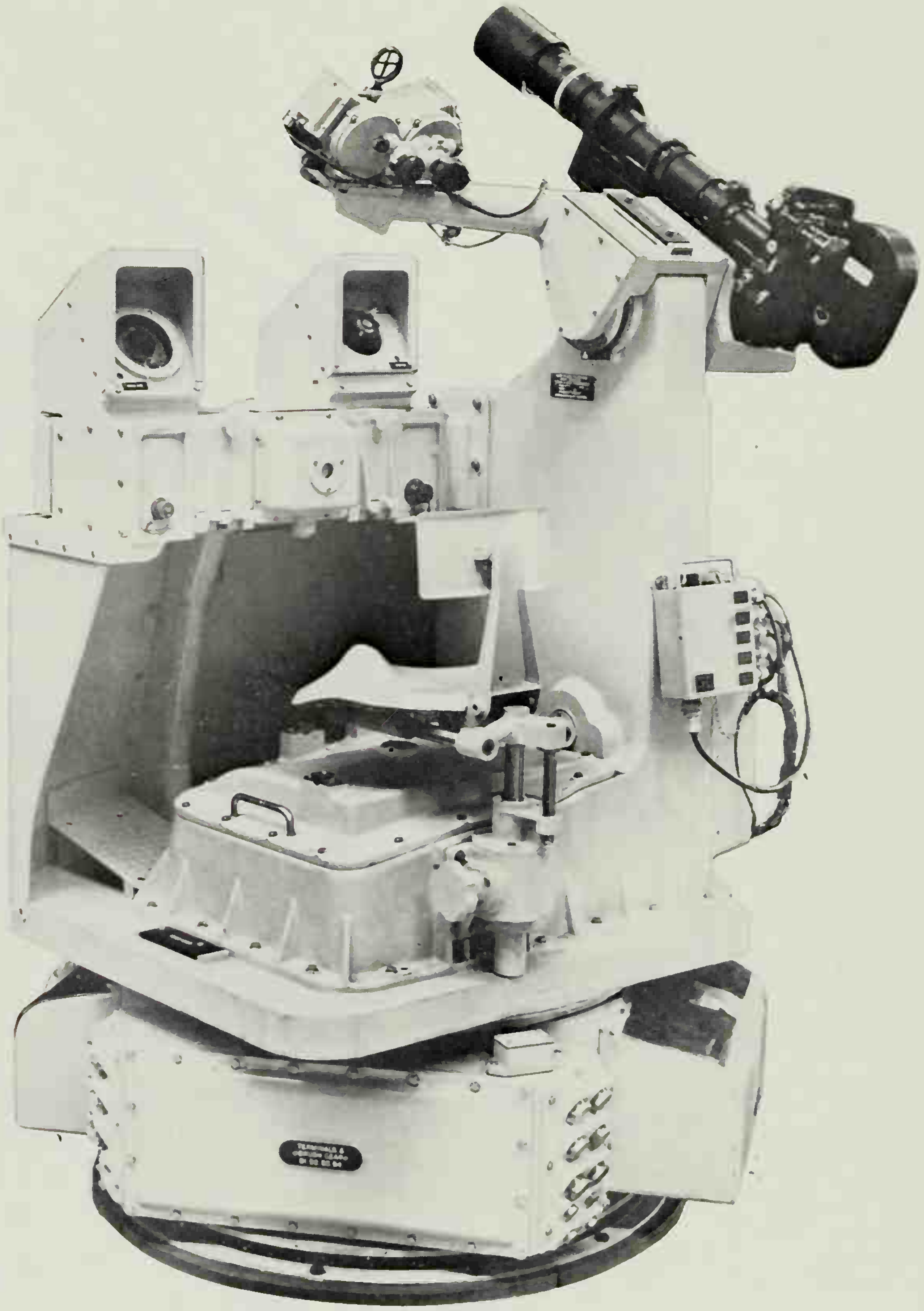
Its elementary construction and simple operation fulfil the requirements of modern customs and coastal patrol launches.

Specification

Type 804/70 cal barrel	**Type 820L/85 cal barrel**
Calibre: 20 mm	20 mm
Muzzle velocity: 835 m/sec (2750 ft/sec)	1050 m/sec 3445 ft/sec)
Rate of fire: up to 800 rounds/min	up to 1000 rounds/min
Feed mechanism: 60-round drum magazine	50-round drum magazine
Weight of mounting: 157 kg (345 lb)	157 kg (345 lb)
Traverse arc: unlimited	unlimited
Elevation arc: −10° to +33°	−10° to +33°
Overall height: 1·6 m (63 in)	1·6 m (63 in)
Swept radius at 0° elevation: 1·7 m (67·5 in)	2·1 m (83 in)
Control: manual operation	manual operation
Gunsight: ring-and-bead type	ring-and-bead type

BRITISH MANUFACTURE AND RESEARCH CO LTD
Springfield Road, Grantham, Lincolnshire, England
Telephone: Grantham 2101 Cables: Marco Telex Grantham Telex: 37635

A MEMBER OF THE
HISPANO SUIZA
ARMAMENTS GROUP



Look-out and aiming sight Mk 1

The look-out and aiming sight Mk 1 covers in one unit the functions which in the past have required separate air look-out sights and aiming sights.

It has been engineered to meet the very arduous environmental conditions encountered at sea in small ships, with the maximum of reliability and the minimum of operator fatigue.

The sight is fully stabilised and its main functions are:

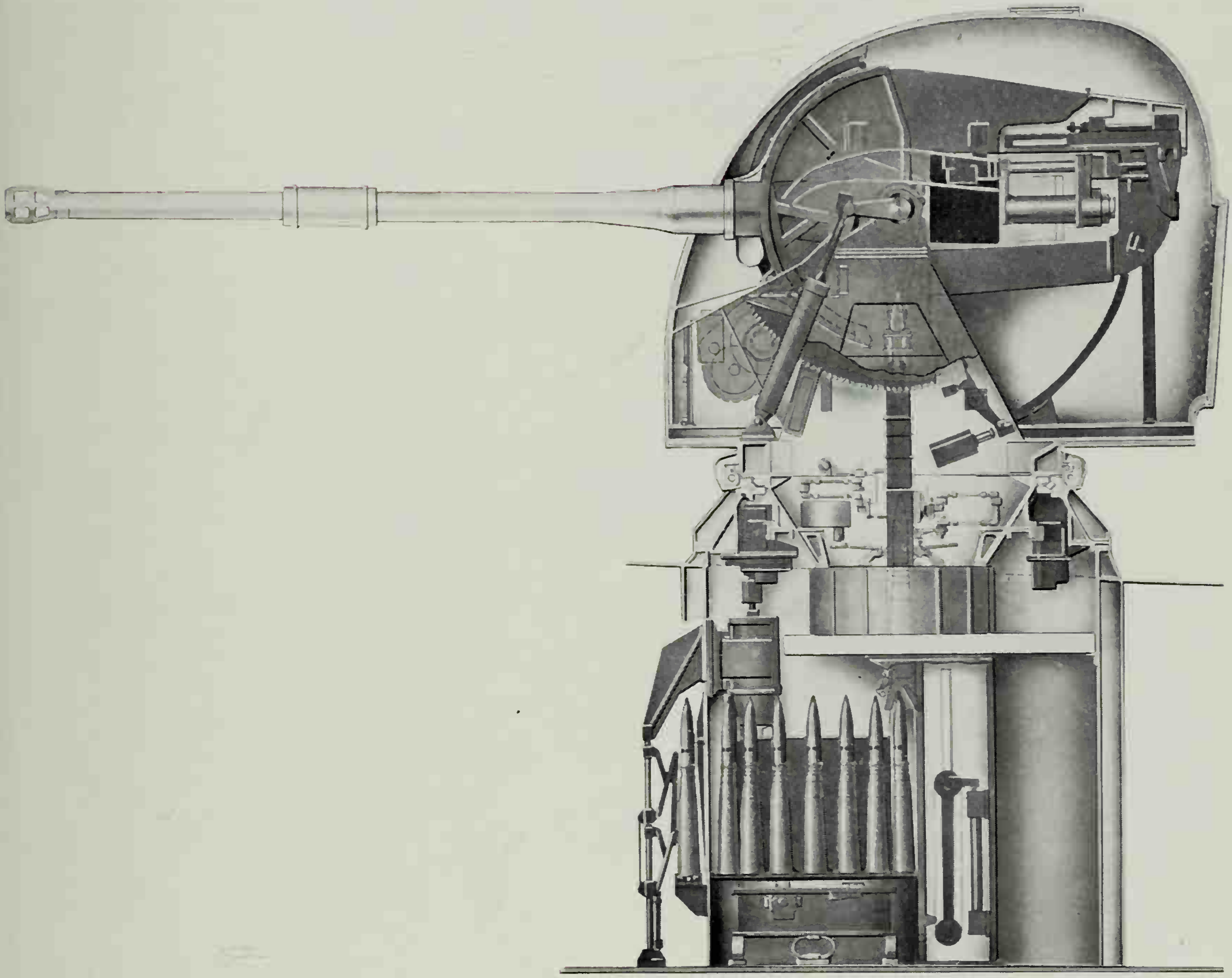
1 To serve as air look-out, particularly for surface and low-flying aerial targets
2 To transmit target indication of such targets to a main fire-control system
3 To be conned by the ship's sensors or by a main fire-control system on to a particular target requiring visual examination, for instance for identification
4 To operate as a visual aiming sight directly controlling an associated gun. Against surface targets, the sight is provided with a surface fire computer contained in an emergency fire control box which is separately manned
5 To be used by a safety officer for practice shoots

In the design the principle of unit construction has been widely applied. This makes the sight readily adaptable to a variety of ship fitting applications as a complete lightweight visual, visual/television or visual/radar fire-control system for guns or guided missiles.

The sight is in production for the Royal Navy, and has the NATO Code No NSN 1265-99-520-9112 under the title 'sight, stabilised, visual and data transmission'.

Gun mounting

and aiming sight for naval guns



4.5 inch Mk 8 gun mounting

The 4·5 in Mk 8 mounting has been specified by the British Naval Staff to give the optimum naval gun for the 1970s and 80s. With fully automatic operation, long range, great accuracy and a high-capacity shell, it has exceptional performance in surface fire and support fire overland.

The mounting employs the new N99 role selective fuse to give the highest probability of destroying low and medium-altitude aircraft and missile targets which pose the major threat from the air in the future.

This round includes the following new features:

1 Improved shell design to give better lethality

2 Cool propellant offering an exceptional increase in barrel life to over 5000 rounds. This avoids frequent barrel changes and reduces costs

3 A unique method of fixing the shell and holding it rigid in the cartridge, so allowing high ramming speeds

4 High muzzle velocity and long range

5 Elimination of primer misfires

6 A new very versatile fuse

VICKERS LIMITED
Vickers House, Millbank, London SW1, England
Telephone: 01-828 7777 Cables: Vickers London SW1 Telex: 27921

Vickers

Electro-magnetic ship's log

AGI electro-magnetic logs provide continuous readings of ship's speed and distance covered with an accuracy and reliability unmatched by any other system. The Royal Navy has specified this equipment for surface and undersea vessels.

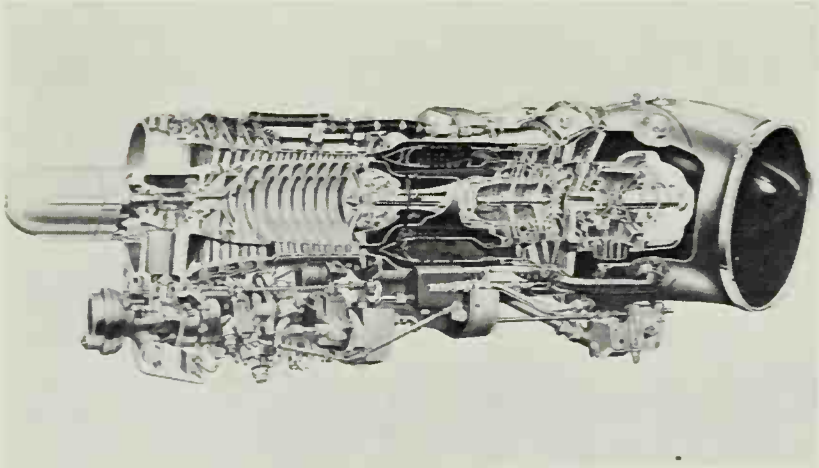
Speed range: 0–60 knots. Accuracy of speed and distance indication: 0·1 per cent of full scale. Other speed and accuracies available. Synchro or dc remote indication. Hull fittings suitable for single and double-skin craft. Independent of salinity. Operator training courses arranged.

Aeronautical & General Instruments Ltd
40 Purley Way, Croydon, CR9 3BH, England

Telephone: 01-684 3211
Cables: Instradio Croydon
Telex: 262960

Section 5

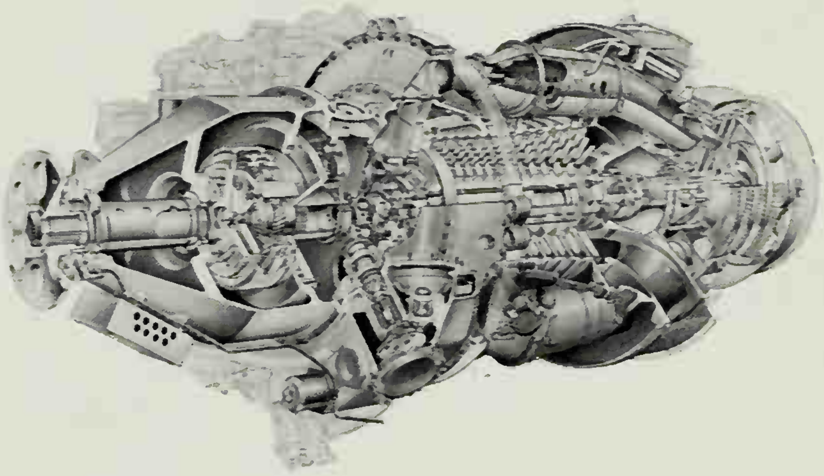
Propulsion and auxiliary machinery



Over 70 000 operating hours have been accumulated by Marine Gnome gas turbines in British hovercraft, such as the SR. N6, since 1964. They have successfully operated in many parts of the world, including regions with such extreme climatic conditions as North Canada, Borneo, Scandinavia, Brunei, Iceland and Libya.

In military operations the Warden Class (SR. N5—one Gnome) and the Winchester Class (SR. N6—one Gnome) have been evaluated in conditions of jungle swamp, ice, over rapids and in river estuaries and coastal waters.

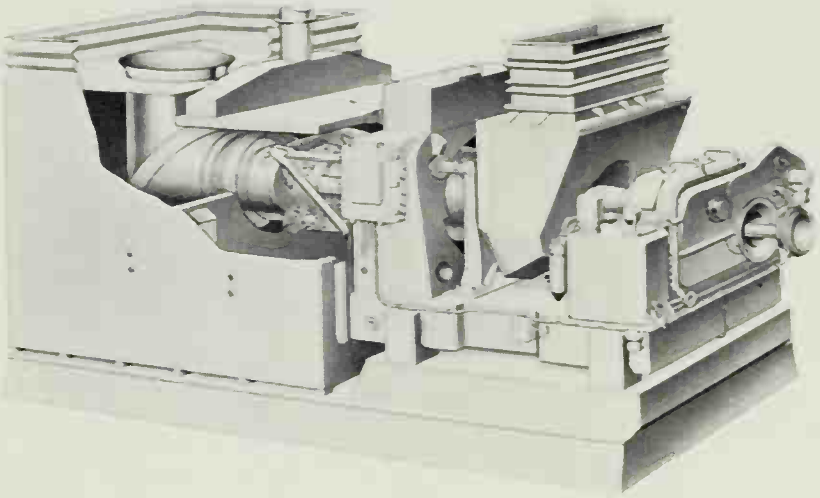
The Marine Gnome is a compact lightweight axial-flow two-shaft engine with a very good power/weight ratio and a low specific fuel consumption



The first Proteus-powered boat HMS *Brave Borderer* commenced sea trials in 1958, and since then the British Royal Navy has had continuous sea experience with the Marine Proteus. In HMS *Brave Borderer*, as in her sister ship HMS *Brave Swordsman*, three Marine Proteus engines form the sole propulsive machinery.

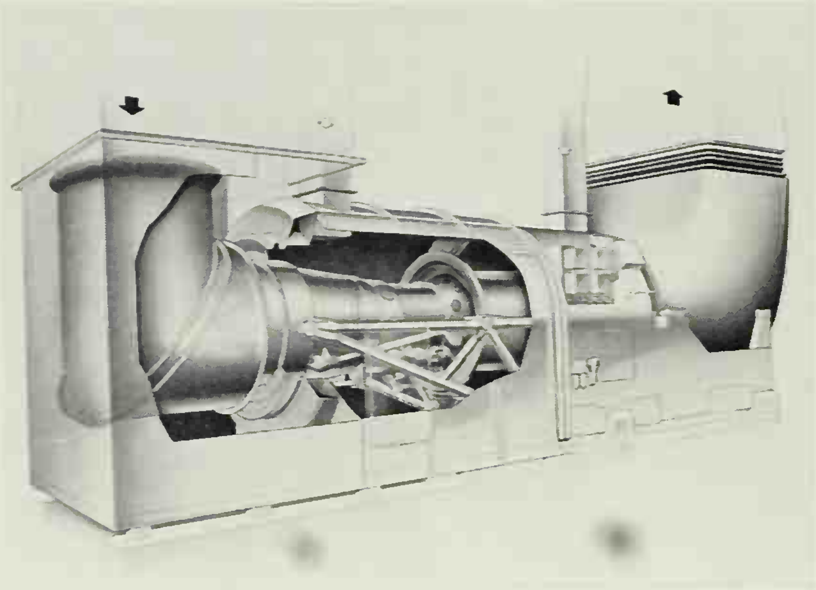
The success of these installations led to the adoption of the Marine Proteus by the navies of Germany, Denmark, Greece, Sweden, Italy, Malaysia, Brunei, Iran, Libya and the USA.

The Marine Proteus also has ideal power characteristics for hydrofoil craft and hovercraft. The Mountbatten Class hovercraft (SR. N4) has four Proteus, the Wellington Class (BH. 7) one Proteus, and the BH. 8 two Proteus engines. The US Navy's hydrofoils USS *High Point* and *Tucumcari* also have Proteus engines



The Marine Tyne RM 1 is a free power turbine engine of 4100 bhp. It has been developed from the earlier Marine Tyne Mk 621 that powers the United States Navy's hydrofoil USS *Flagstaff* and the *Dolphin* passenger-carrying hydrofoil.

The RM 1 has been ordered by the Ministry of Defence (Navy) as the cruise engine for all future frigates and destroyers for the Royal Navy. It will be supplied in a packaged or module form to simplify installation and to ensure easy access for servicing.



The outstanding advantages of the Olympus gas turbine, adopted for larger ships, are derived mainly from its gas generator—a lightweight unit producing high power, and having a long-established reputation for reliability in exacting duties as an aircraft power plant, and in industrial applications.

In 1966 the Admiralty Board approved the conversion of the Blackwood Class Frigate HMS *Exmouth* (1500 tons) to all-gas turbine power. This ship, now in service with the Royal Navy, has one Olympus engine installed for full power with two Proteus engines for cruising. This configuration gives the British Royal Navy the first major warship with all-gas turbine machinery.

The Royal Navy has chosen the Olympus as the boost engine for all future frigates and destroyers. Two engines in module form will be installed in each Type 21 frigate and Type 42 destroyer, with two Tyne engines in a COGOG machinery arrangement. The Type 82 destroyer at present under construction will also have two Olympus gas turbines, and steam turbines in a COSAG arrangement.

Olympus engines are also in service with the Finnish Navy and on order by the navies of Iran, Libya, Malaysia and Thailand.

Gas turbine engines

Marine propulsion units

In 1958 the Royal Navy started sea trials on a new class of fast patrol boat powered by Rolls-Royce marine gas turbines. Since then 13 other navies have ordered Rolls-Royce gas turbines for similar craft. Many are in service. The Royal Navy have now chosen these engines for all future warships.

By the end of 1969 Rolls-Royce marine gas turbines had accumulated 180 000 hours of sea-going experience, and 200 Proteus, 50 Olympus, 29 Tyne and 98 Gnome engines were in service or on order.

All British gas turbine-powered hovercraft in quantity production have Rolls-Royce engines and the second generation of both military and civil hovercraft will have them too.

Specifications

Marine Gnome

The Marine Gnome engine consists of a 10-stage axial compressor driven by a two-stage turbine, an annular combustion chamber and a mechanically independent single-stage turbine which drives the power output shaft.
Max rating: 1050bhp
Continuous rating: 900bhp
Length: 1666mm (65·5in)
Width: 314mm (12·36in)
Height: 519mm (20·4in)
Weight: 147kg (324lb), 201kg (444lb) with reduction gear
Fuel: DERD 1494 Avtur
Fuel consumption: 0·283kg (0·625lb)/bhp/h max
Oil: DERD 2487
Oil consumption: 0·75 litre (1·2pt)/h max

Marine Proteus

The Marine Proteus engine is a simple-cycle, lightweight gas turbine with a combined 12-stage axial and a single-stage centrifugal compressor, eight combustion chambers and independent compressor and power turbines.
Max rating: 4250bhp
Continuous rating: 3400bhp
Length: 2890mm (113in)
Width: 1070mm (42in)
Weight: 1413kg (3118lb)
Fuel: DEF 2402 diesel
Fuel consumption: 0·26kg (0·58lb)/bhp/h max
Oil: OEP 71
Oil consumption: 0·28 litre (0·5pt)/h average

Marine Tyne

The Marine Tyne RM 1 engine has a six-stage low-pressure compressor in tandem with a nine-stage high-pressure compressor, each driven independently by a single-stage turbine through co-axial shafts. The gas generator is connected to a separate two-stage axial-flow power turbine with the drive shaft supported in a pedestal.
Max rating: 4100 bhp
Length: 4343 mm (14 ft 3 in)
Length (complete module): 5562 mm (18 ft 3 in)
Width: 1828 mm (6 ft)
Height: 2692 mm (8 ft 10 in)
Weight: 14 062 kg (31 000 lb)
Fuel: BSS 2869 Class A
Fuel consumption: 0·221 kg (0·494 lb)/bhp/h
Oil: DERD 2493
Oil consumption: 0·56 litre (1 pt)/h max

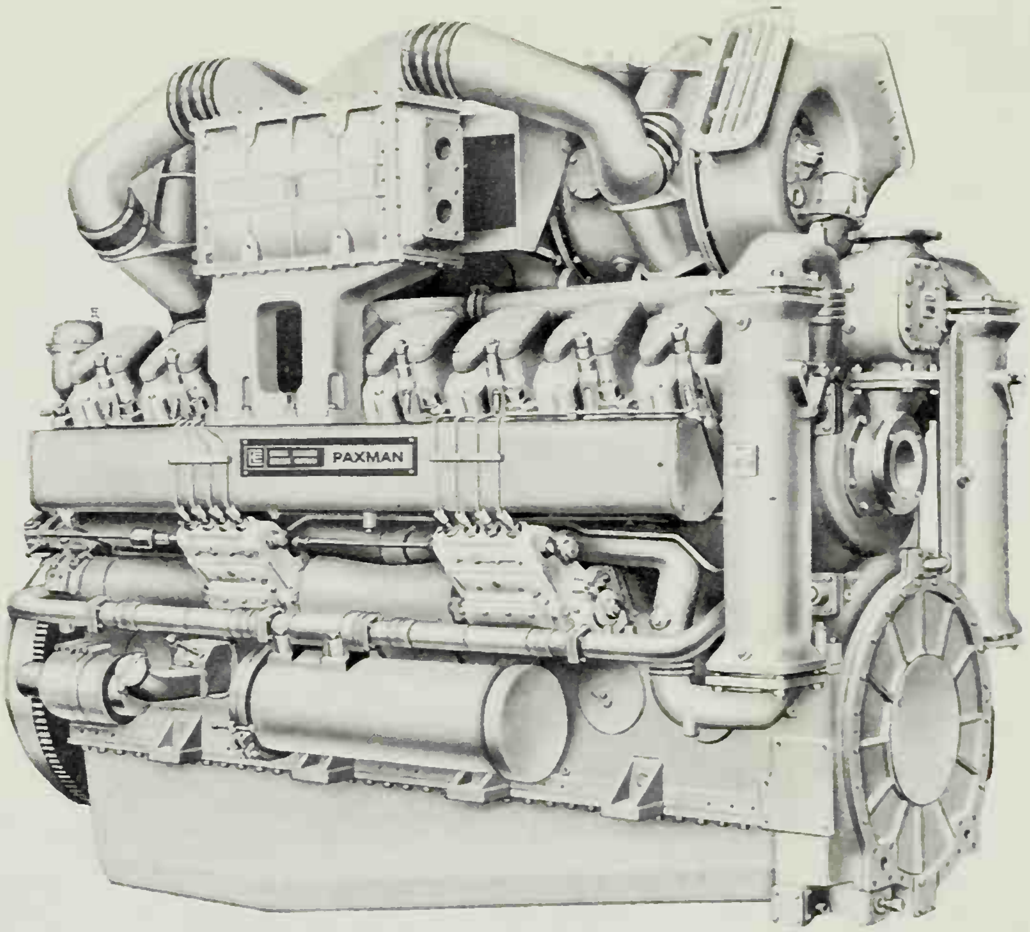
Marine Olympus

The Marine Olympus gas generator is a high-pressure ratio unit with a five-stage low-pressure compressor and a seven-stage high-pressure compressor. Each compressor is driven by its own single-stage turbine through co-axial shafts.

The gas generator is connected to a separate power turbine which is a single-stage axial-flow type, with the rotor shaft supported in a pedestal.
Max rating—TM 3: 27 200bhp
Output shaft speed: 5660rev/min max
Length: 6860mm (22ft 6in)
Width: 3300mm (10ft 10in)
Height: 2900mm (9ft 6in)
Weight: 13 155kg (58 000lb)
Gas generator:
  Length: 3580mm (11ft 9in)
  Width: 1300mm (4ft 3in)
  Weight: 2950kg (6500lb)
Fuel: BSS 2869 class A
Fuel consumption: 0·22kg (0·490lb)/bhp/h max
Oil: DERD 2487
Oil consumption: 0·84 litre (1·5pt)/h max

ROLLS-ROYCE LIMITED
Industrial and Marine Gas Turbine Division
PO Box 72, Ansty, Coventry, CV7 9JR, England
Telephone: Walsgrave-on-Sowe 3211 Cables: Roycov Coventry Telex: 31637

ROLLS
RR
ROYCE



The Paxman 16-cylinder Ventura engine is an outstanding unit for marine propulsion. Light, compact and dependable, it is available in a wide range of rated power to suit naval vessels of many different types

Royal Libyan Navy corvette built by Vosper Ltd powered by twin Paxman 16-cylinder Ventura engines each developing 1900bhp

HMS *Hecate* survey ship has diesel-electric drive by three Paxman 12-cylinder Ventura engines totalling 3840bhp

MOD (Air) long-range recovery and support craft *Seal* powered by two 16-cylinder Ventura engines each rated at 2000bhp at 1485rev/min

Diesel engines

Ventura range for marine propulsion

Paxmans have for many years been leaders in the field of compact, high-output prime movers and the design and construction of the Ventura range is another major technological advance based on experience accumulated from millions of running hours by Paxman vee-form diesels. Particular attention has been paid to:

Compactness All extraneous equipment, oil coolers, free-end drives, etc., are packed inside the overall engine dimensions giving a remarkably small high-powered package.

Low weight This has been achieved with the use of the latest metallurgical and fabricating techniques without sacrificing any of the well-known Paxman ruggedness.

Smooth power flow Stringent control of tolerances and finishing of all moving parts together with ultra-fine balancing of crankshaft and flywheel gives vibration-free running over the full and fluctuating speed/load range.

Quietness The pressure charging combines high volumetric efficiency with a muffling of the exhaust note.

Economy Pressure charging of air into the advanced design combustion chamber with a highly efficient fuel injection system ensures economy of operation and clean exhaust gases.

Maintenance A characteristic of Paxman vee-form diesels is the ability to run for long periods between overhauls, 20 000h in some cases. This, combined with the clear access to components requiring routine maintenance means that down-time is a very small percentage of the total working life.

Interchangeability A large number of wearing parts are common throughout the range and replacement spares, machined to precision limits, can be instantly exchanged without hand fitting. This is of particular benefit to multi-engine installations where a common spares stock can be held.

	Engine speed rev/min	6 YJXM	6 YJCM	8 YJXM	8 YJCM	12 JYXM	12 YJCM	16 YJXM	16 YJCM
Brake hp	1500	550	700	750	925	1150	1400	1530	1850
Brake hp	1250	510	620	680	825	1025	1235	1370	1650
Brake hp	1200	500	600	670	800	1000	1200	1350	1600
Brake hp	1000	450	525	600	700	900	1050	1200	1400

These are continuous ratings intended for sustained high-speed running, meeting the requirements of continuous duty and diesel-electric drive.

Propulsion engines for high-speed patrol craft
Special ratings are available for vessels requiring high power for short periods

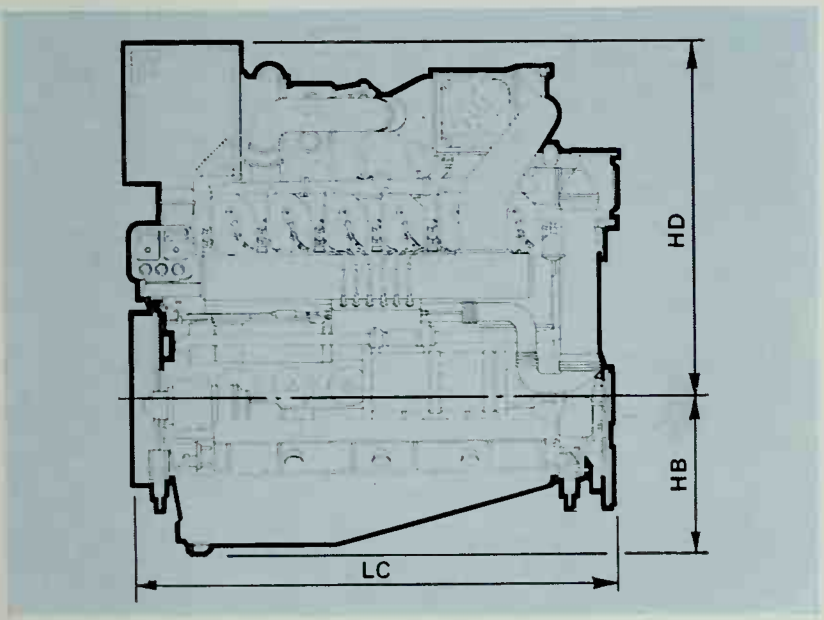
Rating, bhp	Engine speed rev/min	6 YJXM	6 YJCM	8 YJXM	8 YJCM	12 JYXM	12 YJCM	16 YJXM	16 YJCM
Max	1600	750	850	1000	1200	1500	1800	2000	2400
Inter	1550	690	770	920	1100	1380	1650	1840	2200
Cont	1500	625	700	825	1000	1250	1500	1650	2000

Maximum rating is the power available for short periods. Frequent use of this rating may increase maintenance down-time.

Intermittent rating is the power usable for short periods not exceeding 10% of the total running hours.

Continuous rating is intended for sustained high-speed running meeting the requirements of continuous duty as generally applied to patrol craft of the high-speed type. Ratings are for temperatures not exceeding 29°C (YJXM) or with the temperature of the water supply to the intercooler not exceeding 24°C (YJCM).

Engine data
Number of cylinders: 6, 8, 12, 16
Bore and stroke: 197 × 216mm (7·75 × 8·5in)
Cycle: 4-stroke
Compression ratio: 13:1
Full-load speed range: 750–1500rev/min
Mean piston speed at 1500rev/min: 10·8m/sec (2125ft/min)



Dimensions and weights (engine and coupling only)

Engine	LC = Length mm (in)	Width over bearers mm (in)	HB = Height mm (in)	HD = Height mm (in)	Dry weight kg (lb)
6 YJXM	1745 (68·75)	1137 (44·75)	641 (25·25)	1257 (49·5)	3660 (8050)
6 YJCM	1745 (68·75)	1137 (44·75)	641 (25·25)	1257 (49·5)	3750 (8275)
8 YJXM	1850 (72·75)	1137 (44·75)	641 (25·25)	1675 (66·0)	4250 (9350)
8 YJCM	1850 (72·75)	1137 (44·75)	641 (25·25)	1675 (66·0)	4360 (9600)
12 YJXM	2220 (87·5)	1283 (50·5)	711 (28·0)	1638 (64·5)	5180 (11 400)
12 YJCM	2220 (87·5)	1283 (50·5)	711 (28·0)	1638 (64·5)	5460 (12 025)
16 YJXM	2720 (107)	1283 (50·5)	743 (29·25)	1675 (66·0)	6950 (15 300)
16 YJCM	2720 (107)	1283 (50·5)	743 (29·25)	1675 (66·0)	7220 (15 900)

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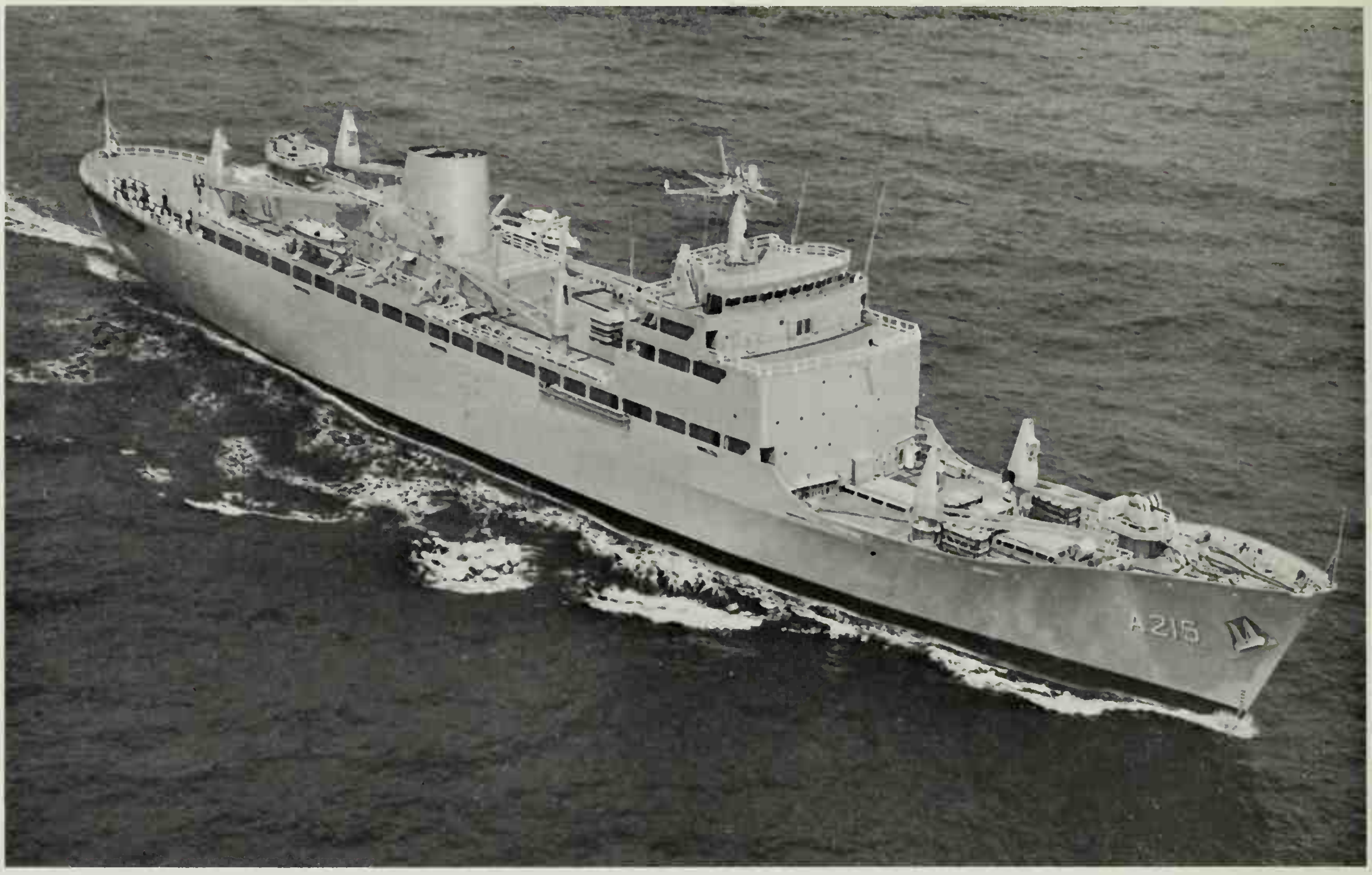
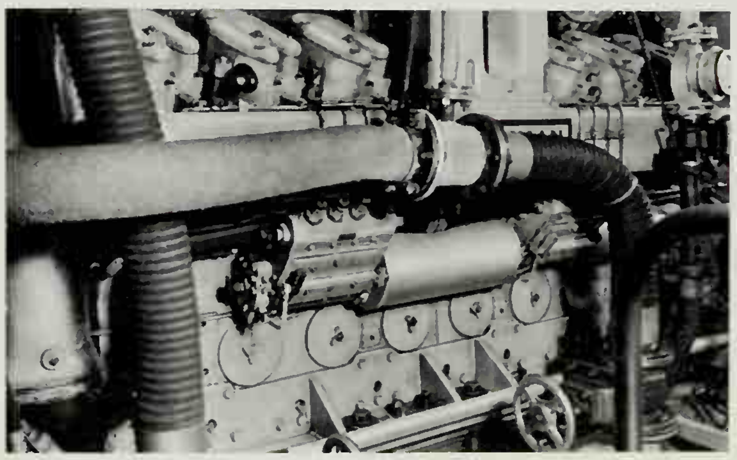


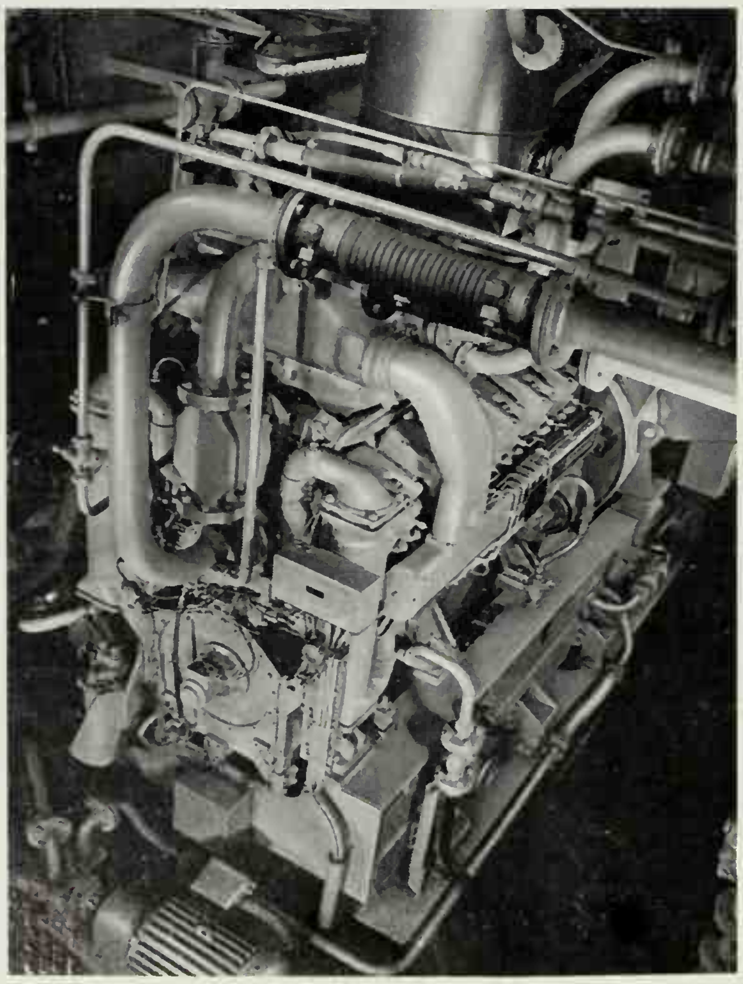


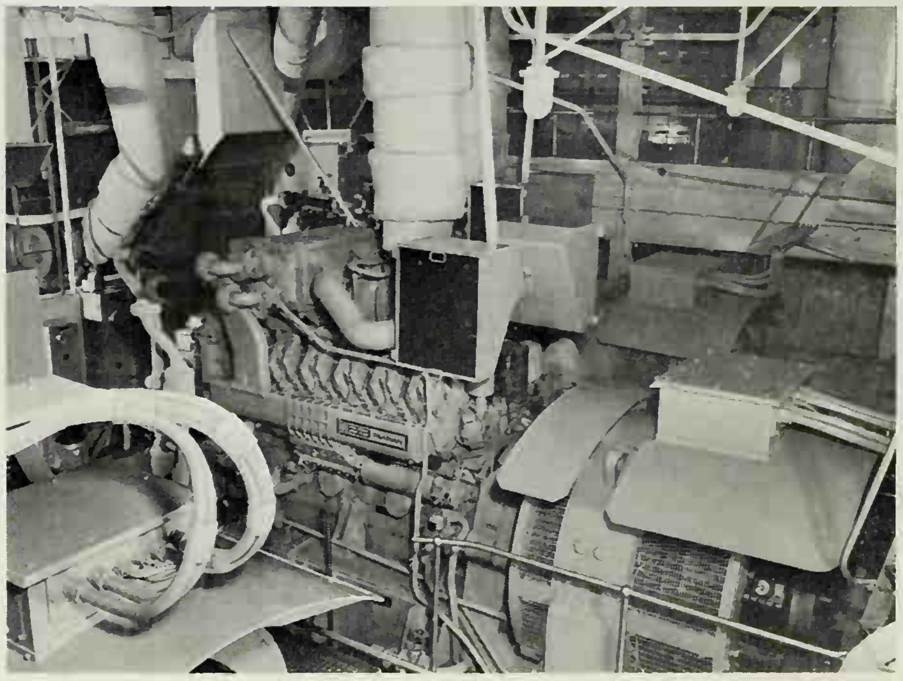
Top: escort maintenance vessel RNAS *Stalwart* with five 16 YJCAZ and two 12 YJCAZ engines installed

Left: one of the 16-cylinder Ventura engines installed in HMS *Fife*, a County Class guided missile frigate, for supplying electrical power

Below: a view of the engine room of HMS *Hecate*, a Royal Navy survey ship. Powered by three 12-cylinder Ventura engines coupled with generators each producing 610kW for main propulsion duties, there are also two 6-cylinder Paxman engines coupled to 300kW generators for electrical power supplies

Below left: a 750kW Paxman Ventura generating main standby set installed in supertankers *Esso Malaysia* and *Esso Mercia*. Paxman-powered generators supply power for various duties including emergency and auxiliary power for fire pumps and deck machinery for 16 vessels completed or building in European shipyards





Diesel engines

for marine auxiliary duties

Backed by over a century of engineering experience, the Paxman range of marine auxiliary diesel engines offers many characteristic advantages. There is the high output combined with a relatively low weight, compactness which is a main advantage of the vee-form design, smooth running, long service life between overhauls, and the ability to operate satisfactorily on marine diesel oil Class B. In addition, the higher outputs of the smaller units in the range make them particularly suitable for driving the modern 60Hz ac generator.

The Paxman range of auxiliary engines covers outputs of from 100 to 1920bhp, with from four to 16 cylinders, and can be supplied with natural aspiration, turbo-charging, or turbo-charging with charge intercooling. The range covers four basic designs, with many of the wearing parts commonly interchangeable. First is the RPH, with outputs from 137 to 825bhp and speeds of up to 1500rev/min. The result of some 30 years of progressive development, this series of heavy-duty engines has a proven history of reliability and a service life unsurpassed by any other make of diesel throughout the world. Second is the YH series, a direct-injection version of the RPH, with outputs ranging from 690 to 1100bhp. Third is the YJ, one of the most powerful engines in its weight class now in production; it is particularly suitable for installations where space considerations are all-important. Adopted as standard by the Ministry of Defence (Naval), the YJ—or Ventura as it is called—has an output ranging from 475 to 1920bhp.

Although outputs are high, running costs are low—these are easily-proven facts. The shorter stroke of the Paxman engine means that piston speed, the really vital factor, is most moderate. For example, the 197mm (7·75in) stroke (RPH or YH) diesel running at 1200rev/min has a piston speed of 470m/min (1550ft/min). This may be compared with a vertical unit of similar power but with a 305mm (12in) stroke which, at 750rev/min, would have a piston speed of 460m/min (1500ft/min). Other features contributing to the low running costs are the small size and low weight of the cylinder heads, pistons and other components, which make overhaul and maintenance a simple procedure. Periods between major overhauls often exceed 20 000h.

Because of their inherent reliability, Paxman marine auxiliary engines are particularly suitable for multi-unit installations operating under remote or automated control.

Typical outputs, dimensions and weights

	Marine auxiliary rating bhp/kW						Length		Width		Height		Weight	
Engine	rev/min:1500		1200		1000		mm	in	mm	in	mm	in	kg	lb
4RPHZ	176	121	168	111	137	92	2410	95	1500	59	1700	67	4380	9560
4RPHXZ ..	223	154	211	143	190	130	2460	97	1500	59	1680	66	4670	10 300
4RPHCZ ..	275	188	273	184	241	163	2460	97	1500	59	1800	71	4800	10 550
6RPHZ	274	188	244	165	209	142	2720	107	1500	59	1750	69	5520	12 150
6RPHXZ ..	334	231	317	217	286	196	2740	108	1500	59	1700	67	5670	12 500
6RPHCZ ..	413	286	409	280	362	245	2790	110	1500	59	1800	71	5920	13 050
8RPHZ	366	255	325	221	280	190	3070	121	1500	59	1750	69	6400	14 150
8RPHXZ ..	447	312	422	290	380	262	3120	123	1500	59	1780	70	6720	14 850
8RPHCZ ..	550	383	546	376	482	334	3120	123	1650	65	1800	71	6870	15 100
12RPHZ ..	618	432	512	355	440	303	3580	141	1520	60	1960	77	8470	18 650
12RPHXZ ..	671	465	634	438	572	394	3730	147	1520	60	2130	84	9900	21 850
12RPHCZ ..	825	581	820	573	724	450	3810	150	1520	60	2240	88	10 300	22 700
12YHXZ	960	670	900	630	700	505	4545	179	1675	66	2195	86·5	9880	21 800
12YHCZ	1030	720	850	600	738	520	4700	185	1650	65	1860	73	10 750	23 725
6YJXZ	600	415	550	380	475	330	3480	137	1450	57	1995	77	7860	17 350
6YJCZ	700	490	610	425	550	380	3480	137	1450	57	1995	77	8120	17 820
8YJXZ	825	578	735	512	660	458	3710	146	1575	62	2440	96	9270	20 400
8YJCZ	960	675	840	590	770	539	3835	151	1575	62	2440	96	9850	21 770
12YJXZ	1230	870	1100	770	990	693	4215	166	1700	67	2540	100	11 250	27 000
12YJCZ	1440	1020	1260	890	1160	814	4140	163	1675	66	2640	104	12 600	27 800
16YJXZ	1650	1165	1470	1045	1320	930	4750	187	1675	66	2665	105	14 000	33 050
16YJCZ	1920	1365	1680	1200	1540	1090	4800	189	1780	70	2665	105	15 400	34 050

Z denotes marine auxiliary or diesel-electric propulsion
For diesel-electric propulsion ratings are reduced by approximately 10 percent
Weight includes underbase and generator
X Denotes pressure-charged
C Denotes intercooled pressure-charged
Starting equipment: electric, air or hydraulic
The marine auxiliary rating complies with Lloyd's unrestricted service requirements for engines operating in ambient temperatures up to 45 C (normally aspirated or pressure-charged) or 30 C seawater temperature (intercooled, pressure-charged). For diesel electric propulsion and pumping duties, the temperatures are 29 C and 24 C

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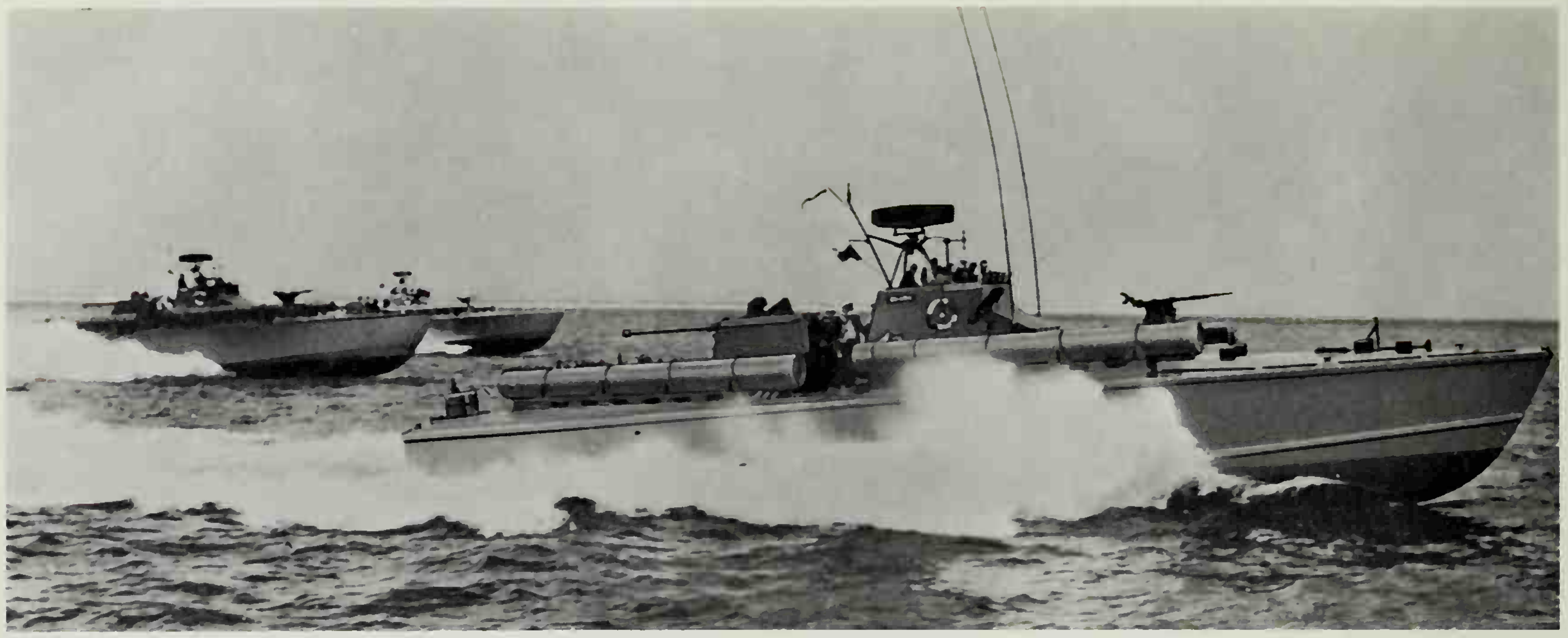


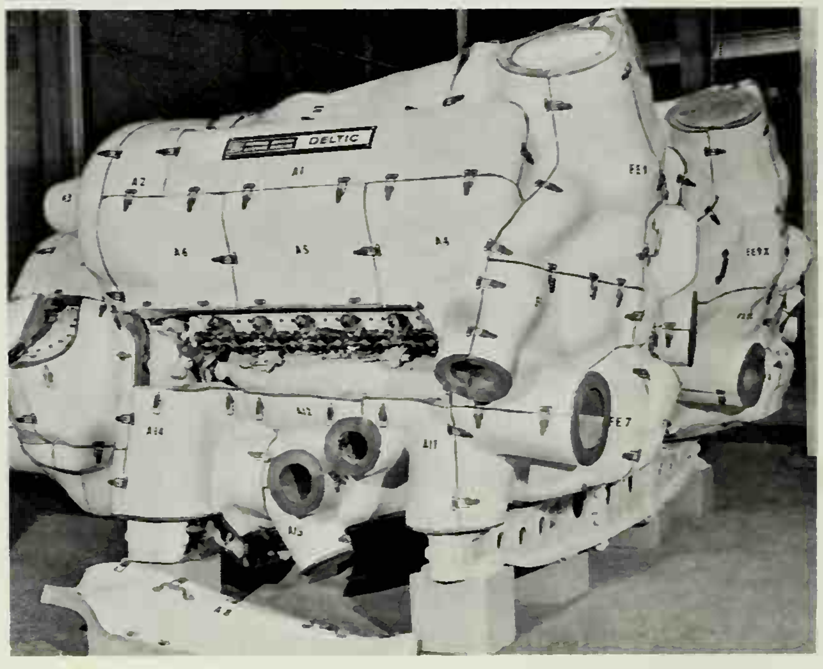
Top: Deltic-powered fast patrol boats of the Royal Norwegian Navy. These 'Nasty' class FPBs have two turbocharged engines of 3100shp each

Upper left: a motor torpedo boat of the Japanese Maritime Self Defence Force powered by three Deltic turbo-blown engines developing a total of 9300shp

Lower left: a fast patrol boat of the Peruvian Navy powered by two turbocharged Deltic engines developing a total of 6200shp

Bottom left: a 'Ton' class coastal minesweeper of the Royal Australian Navy. Over 65 of this class of ship powered by two Deltic engines each of 1500shp are in service throughout the world

Bottom right: an installation pair of accoustically clad Deltic engines for a coastal minesweeper. Panels can be easily removed for servicing purposes



Diesel engines

Deltic range for marine propulsion

The Deltic engine was designed specifically for use by the Royal Navy and, although unique in the triangular arrangement of cylinder blocks, crankcases and crankshafts, only proven principles of opposed-piston practice, and the equally proven fork-and-blade rod design fitted in countless vee-form engines of conventional type are used.

The triangular configuration, coupled with the extensive use of light alloy for the engine castings, has considerable advantages, providing an extremely compact power unit with, for a compression-ignition engine, an unusually high power/weight ratio. For example, the CT18-42K engine (see engine data) offers 3840bhp with a ratio of 1·43kg/hp (3·15lb/hp), bmep is conservatively rated at 9·45kg/cm^2 (134·4lb/in^2).

A special feature of the Deltic range of marine engines is the reverse reduction gearbox which can be supplied as a unit integral with the engine. Even when fitting this unit, a power/weight ratio of just under 1·8kg/shp (4lb/shp) is achieved and the basic concept of a compact power unit is enhanced by this feature.

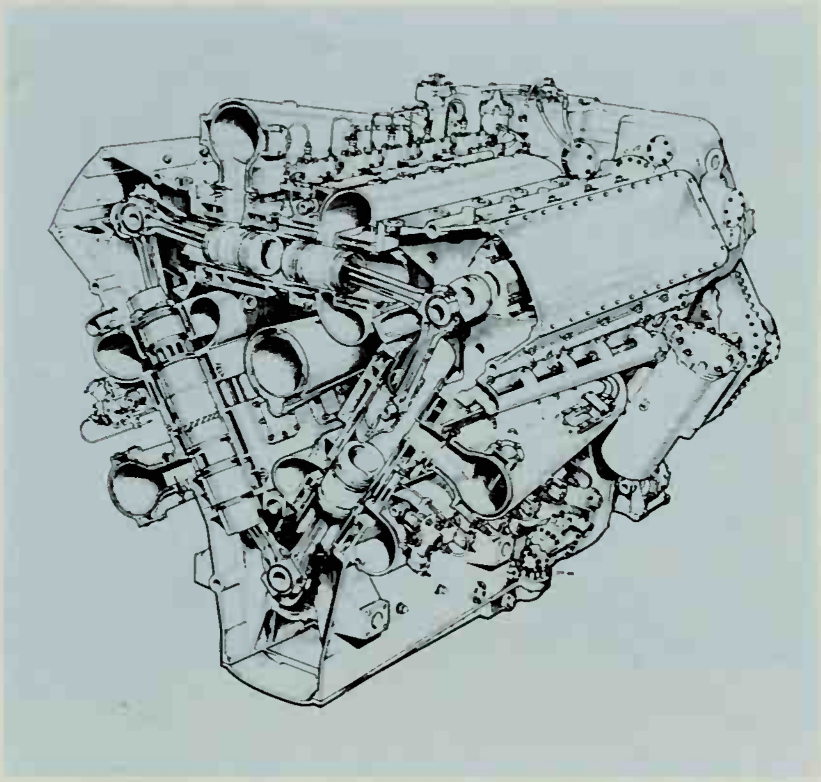
The original specification called for an engine with a low maintenance factor capable of being dealt with by semi-skilled engine room staff, and only minor attention is called for during the life of the engine up to major servicing. The complete interchangeability of common parts and components, such as auxiliary pumps and control units, permits the extensive use of the repair-by-replacement technique. Major units of the engine such as the blower, phasing gear case and reverse reduction gearbox, are also interchangeable thus reducing servicing time.

For fast patrol boat installations where boat trim and space limitations are of major significance, a vee-drive gearbox can be supplied which enables a particularly compact installation arrangement to be achieved. To match the concept of light weight and compactness, a special range of ancillary installation equipment has been developed in conjunction with the respective manufacturers of exhaust and air intake silencers, coolant heat exchangers, oil coolers and priming pumps.

A Deltic-engined installation offers substantial advantages where weight and space affect the performance of the vessel and often make possible machinery arrangements previously considered impracticable.

Acoustic cladding

Special acoustic cladding has been developed to reduce diese noise. It is arranged in easily removable panels. As regards heat insulation, it is assumed that 2 percent of the total heat energy available from consumed fuel in a liquid-cooled engine can be accounted for in radiation. Although the acoustic cladding is not a complete insulator, it can be expected that a total increase in cooling capacity of approximately 5 percent would be required and it is suggested that the normally fitted coolers (with excess capacity in the order of 10–15 percent) would accommodate this increase. This cladding method can also be applied to other diesel engines.



Section through No 2 cylinders of Deltic Type CT18-42K

Technical data common to all Deltic marine engines

No of cylinders 18; cylinder bore 130·2mm (5·125in); stroke 184mm × 2 (7·25in × 2)

Deltic engines are opposed-piston compression-ignition engines operating on the two-stroke cycle and employ either a mechanically driven scavenge blower or a turbocharger. On the higher rated 'CT' engines charge-air coolers are introduced and are integral with the turbocharger unit. The engines are liquid-cooled with a closed circuit system incorporating thermostatic valves and heat exchangers. Lubrication system is on the dry sump principle with scavenge oil pump returning oil to a service tank via an oil cooler; a thermostatic valve controls the temperature.

Engine data

Engine type	Continuous rating bhp	Maximum power bhp	Speed range rev/min	Full-load bmep kg/cm^2 (lb/in^2)	Piston speed at maximum m/sec (ft/min)	Full-load fuel cons. g/bhp-h (lb/bhp-h)	Engine weight less gearbox kg (lb)	Overall length less gearbox mm (in)	Overall width mm (in)	Overall height mm (in)
18-25K	1725	1900	600/ 1550	6·34 (90·2)	9·51 (1873)	160·3 (0·358)	4605 (10 350)	2337 (92)	1905 (75)	2134 (84)
18-39K*	1970	2630	600/ 2000	85·7 (97·1)	9·51 (1873)	172·8 (0·386)	4513 (9950)	2337 (92)	1905 (75)	2134 (84)
T18-27K	2200	2420	600/ 1650	7·58 (107·8)	10·12 (1994)	162·9 (0·364)	5071 (11 180)	3048 (120)	1905 (75)	2314 (84)
T18-37K* . .	2500	3240	600/ 2100	7·98 (113·4)	12·88 (2537)	171·1 (0·382)	4890 (10 780)	3048 (120)	1905 (75)	2134 (84)
CT18-42K* . .	2850	3840	600/ 2100	9·45 (134·4)	12·88 (2537)	173·8 (0·388)	5852 (12 900)	3120 (123)	1778 (70)	2007 (79)
CT18-50K* . .	3100	4140	600/ 2100	8·62 (145·0)	12·88 (2537)	170·8 (0·380)	5852 (12 900)	3120 (123)	1778 (70)	2007 (79)

The prefix T to the engine type denotes a turbocharged engine, CT denotes turbocharging with integral charge-air coolers. Engines with no prefix letter have mechanically driven scavenge blowers

* Sprint rated engines, generally for fast patrol boat applications

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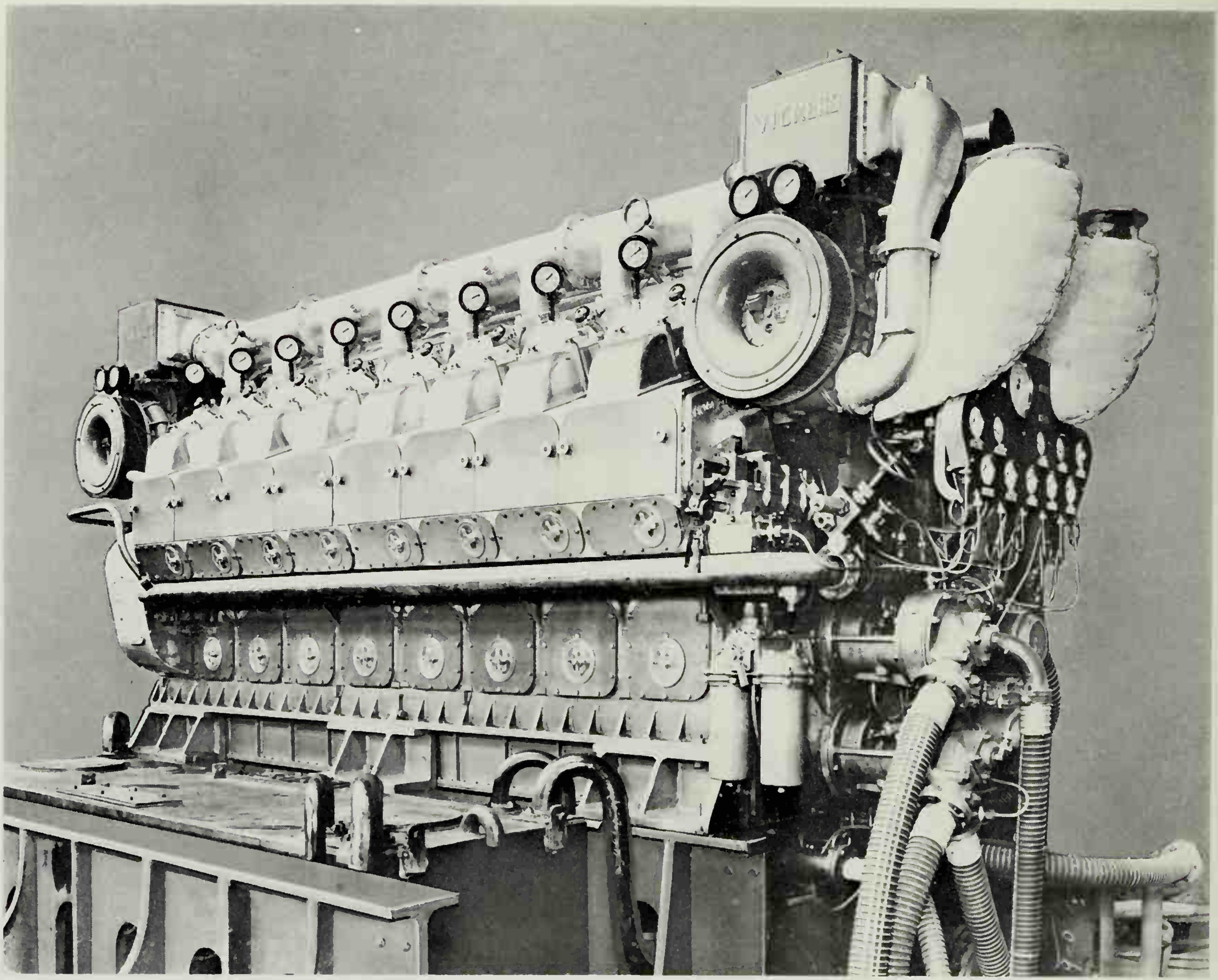

Above: Type 16 VTS engine on test

Below: Indian Navy frigate *Beas*

Diesel engines

ASR 1 range for marine propulsion

Vickers has been manufacturing the highly successful Admiralty Standard Diesel Engines Range 1 since 1948 and has supplied them for submarines, frigates, tugs and aircraft carriers.

Modifications have been constantly introduced to take advantage of modern developments and to keep abreast of the latest technology. Many navies abroad have taken advantage of this proven design and current users include Australia, Canada and India.

The basic design of engine is such that variations for specific purposes are easily made, which facilitates their use in such a wide range of vessels.

The in-line version, which may be normally aspirated or supercharged, has either six or eight cylinders and is eminently suitable for auxiliary generating engines, being rated at 360 kW and 550 kW respectively.

The V-type is available with either 12 or 16 cylinders and may be normally aspirated, supercharged by turbo-blowers or mechanically supercharged.

Brief technical particulars of the various types are shown in the accompanying table.

The photograph on the opposite page shows a 16 VTS engine on the test bed. Normally eight engines of this type (four operating clockwise and four counter-clockwise) are fitted as main propulsion in Admiralty frigates. Vickers has recently completed and supervised the installation of a set of these engines in a frigate built by Yarrow (Shipbuilders) Ltd.

Previous frigates engined by Vickers include HMS *Salisbury* and *Leopard* as well as *Beas* and *Betwa* for the Indian Navy.

Auxiliary generating sets have also been supplied for HMS *Llandaff, Chichester, Ausonia, Lynx* and *Brahmaputra,* and the aircraft carrier HMS *Hermes,* while the 12 VTS engines have been fitted in the Admiralty tug HMS *Typhoon.*

Vickers is known the world over as submarine builders and has been closely associated with the British Admiralty and most other naval countries of the world in the production of complete vessels.

Although the first Barrow-built engines for submarines were petrol-driven in about 1903, they were soon followed by the first diesel engines in 1908, and Vickers has been constantly engaged in this field ever since.

Many of the highly successful Oberon Class submarines, each of which incorporates two 16 VMS diesel generating sets for main propulsion, were built by Vickers.

Specification

ASR 1 diesel engines

Type		6 LTS	8 LTS	12 VTS	16 VTS	16 VMS
Bore	mm in	247·7 9·75	247·7 9·75	247·7 9·75	247·7 9·75	247·7 9·75
Stroke	mm in	266·7 10·5	266·7 10·5	266·7 10·5	266·7 10·5	266·7 10·5
Speed	rev/min	720	720	920	920	920
Maximum bhp	Continental UK	532 525*	786 775†	1460 1440	1967–2028 1940–2000	1866 1840
BMEP	kN/m^2 lb/in^2	848 123	938 136	903 131	931–945 135–137	871 126·3
Length	m in	4·8 189	5·69 224	4·8 189	5·7 224·75	5·66 223
Breadth	m in	1·3 51	1·3 51	1·7 67	1·7 67	1·78 70
Height	m in	2·82 111	2·87 113	2·59 102	2·59 102	3·05 120
Weight	kg tons	10 160 10	13 716 13·5	14 732 14·5	18 035 17·75	21 336 21

*Output with generator 360 kW
†Output with generator 550 kW

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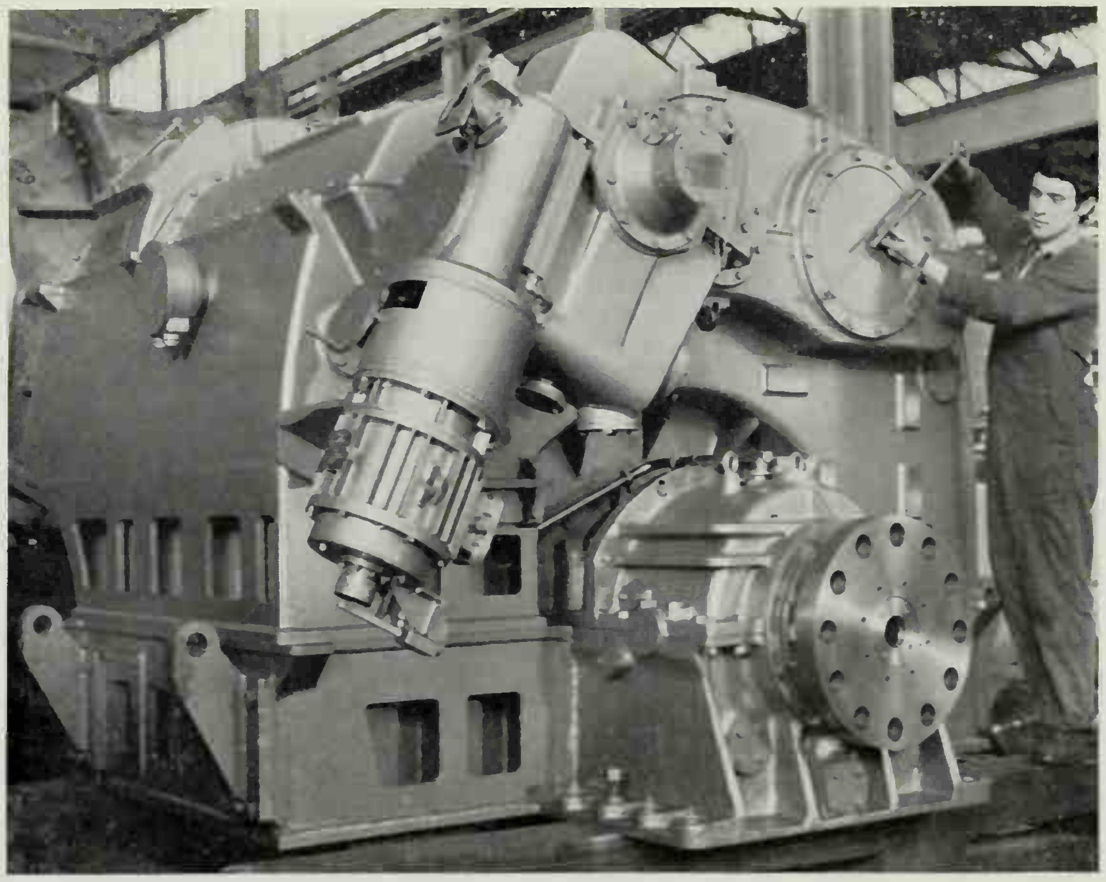
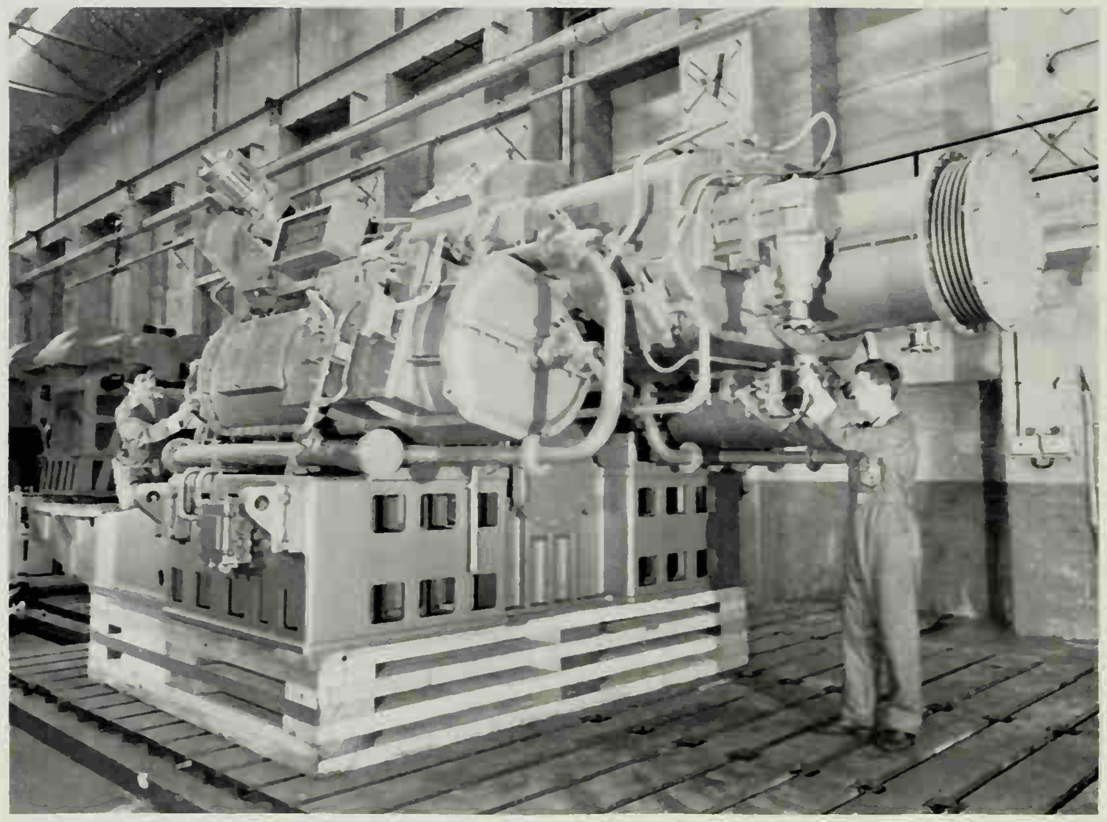
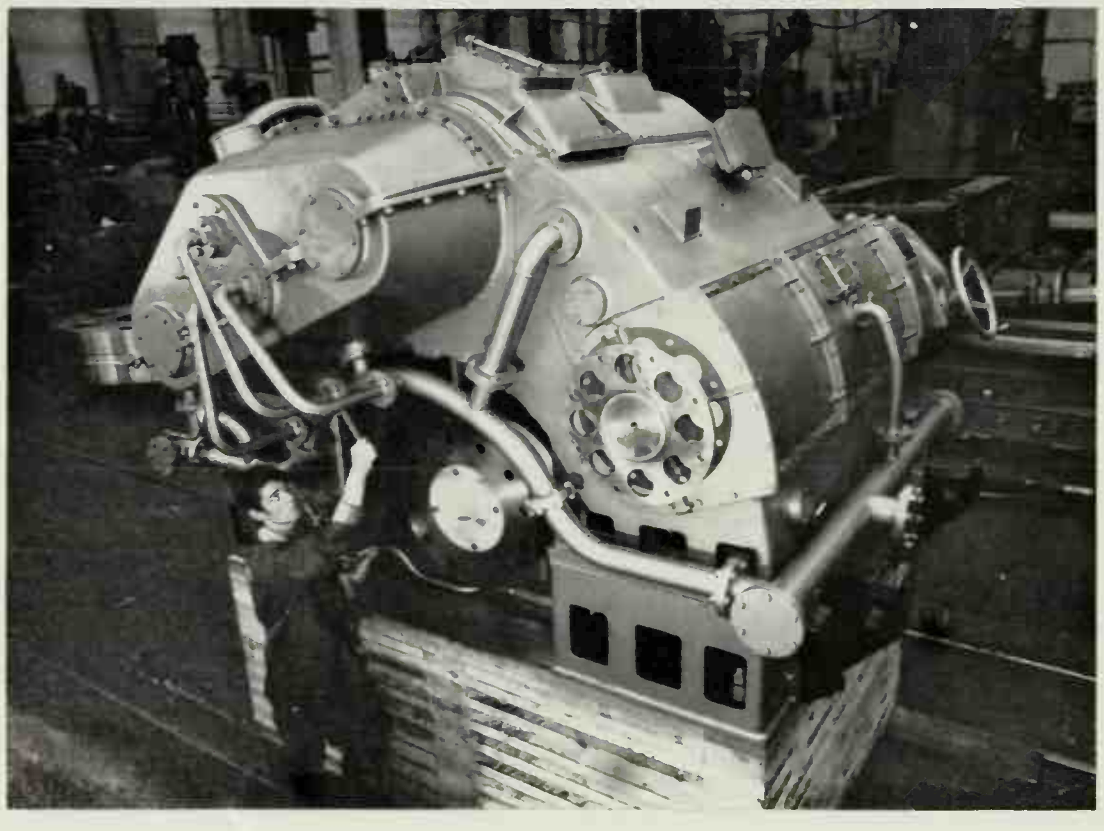
Vickers



Main propulsion gearing for improved Leander Class frigates
This double-reduction double-helical main propulsion gear unit designed for the improved twin-screw Leander Class frigates is of dual tandem articulated design driven by a single steam turbine. The all-welded gearcase, fabricated at the David Brown plant at Penistone, shows how modern welding techniques produce the finest possible results with an extremely complex design



Main propulsion gearing for HMS *Exmouth*
With double-reduction double-helical gearing, this main propulsion gear unit was designed for the Royal Navy frigate HMS *Exmouth*, the world's first all-gas turbine major warship. This massive gearbox, a dual tandem locked-train unit with self-synchronising clutches, is a complex design to transmit the drive from two alternative sources of gas turbine power. An Olympus engine, positioned forward of the gear unit, supplies the main power, and two Proteus engines, located aft, supply power for normal cruising



Main propulsion gear unit for Vosper Mk 5 and Mk 7 fast destroyers
The Vosper Mk 5 and Mk 7 marine gearbox is a double-reduction single helical main propulsion gear unit designed for the series of fast destroyers being built for the Imperial Iranian Navy and the Libyan Navy by Vosper Thornycroft. The gearing is of dual-tandem locked-train design and transmits the drive from two alternative power sources, an Olympus gas turbine for the main drive, positioned forward, and a Paxman diesel engine, located aft, for normal cruising

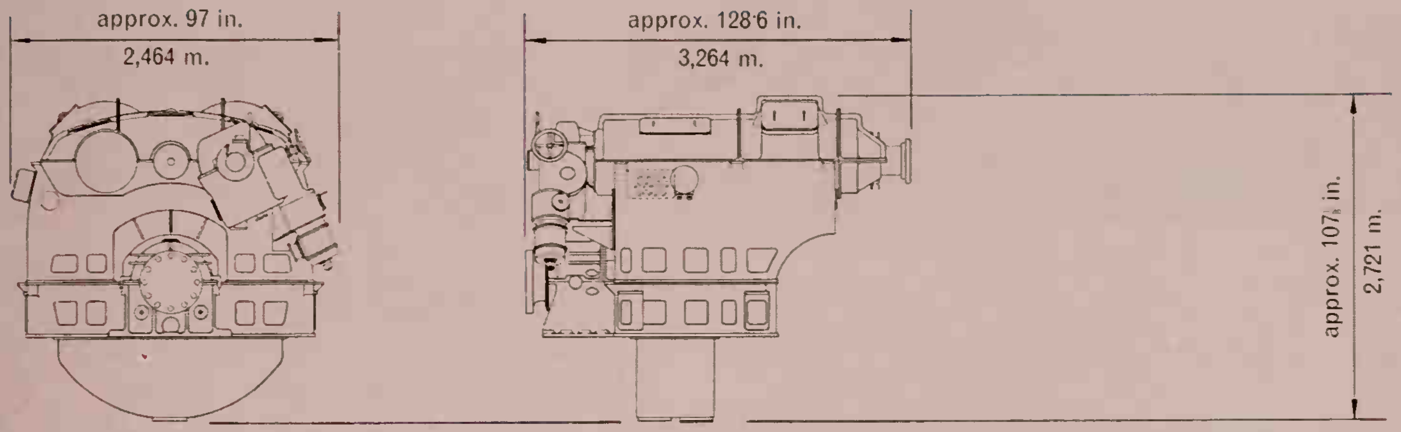
Gearing

for marine main propulsion

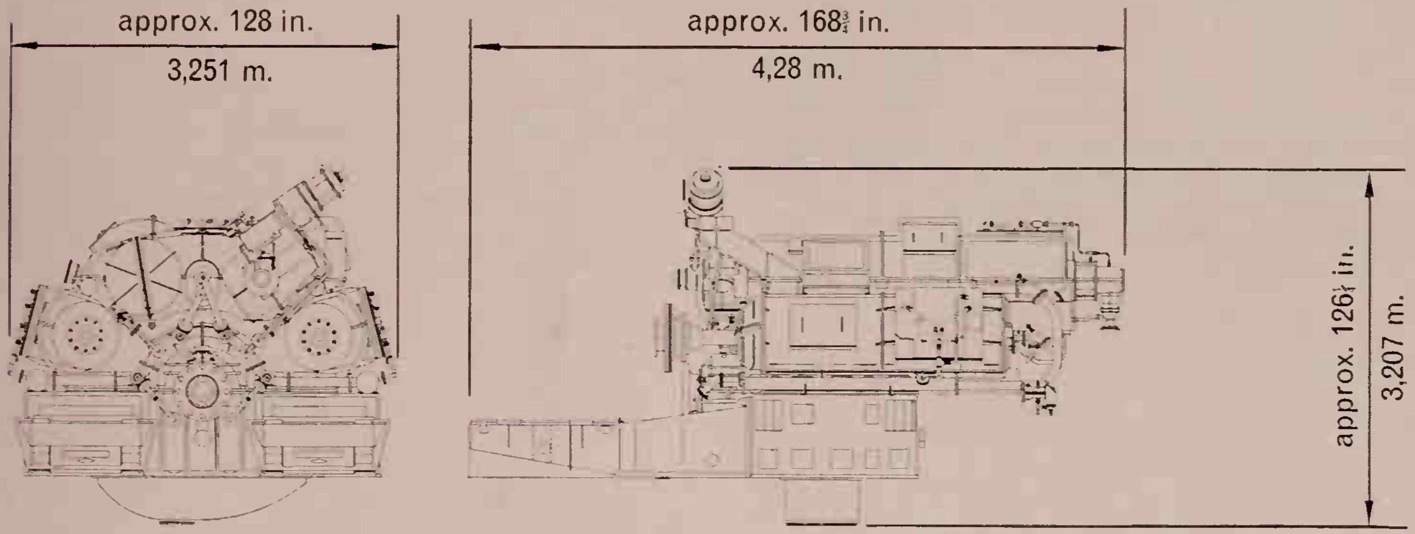
For well over half a century David Brown have played a prominent role in the design, development and manufacture of main propulsion gearing for naval ships, working in close collaboration with the Ministry of Defence (Navy Department).

David Brown have contributed greatly to post-war gearing developments, in close involvement with the work of NAVGRA and considerable progress has been made in the use of hardened gears. Produced under 'clean air' conditions of strict temperature and humidity control, David Brown gears are well within the limits demanded by British Standard 1807, Part 1, Class A1, for pitch, profile, helix and balance.

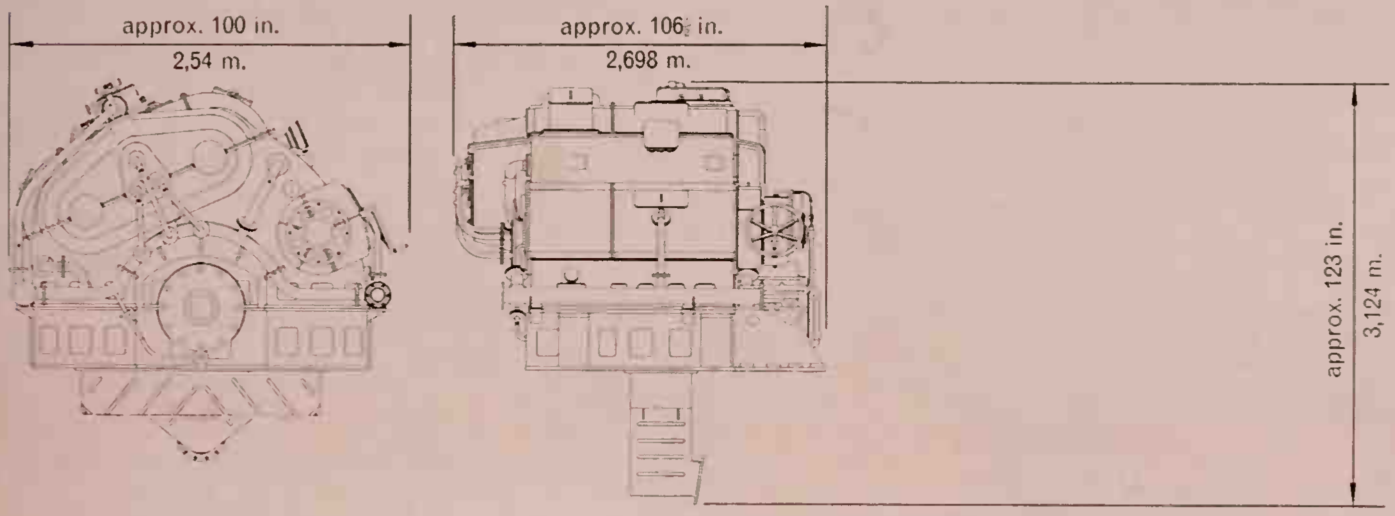
Examples of designs produced include those for Whitby Class frigates, Leander and improved Leander Class frigates, assault ships and others, while of recent date a David Brown gearbox was fitted in the all-gas turbine ship HMS *Exmouth*. Present contracts include the design and manufacture of main propulsion gear units for the projected type 42 gas turbine-driven ships.


approx. 97 in.
2,464 m.
approx. 128·6 in.
3,264 m.
approx. 107⅛ in.
2,721 m.

Main propulsion gear unit for improved Leander Class frigates

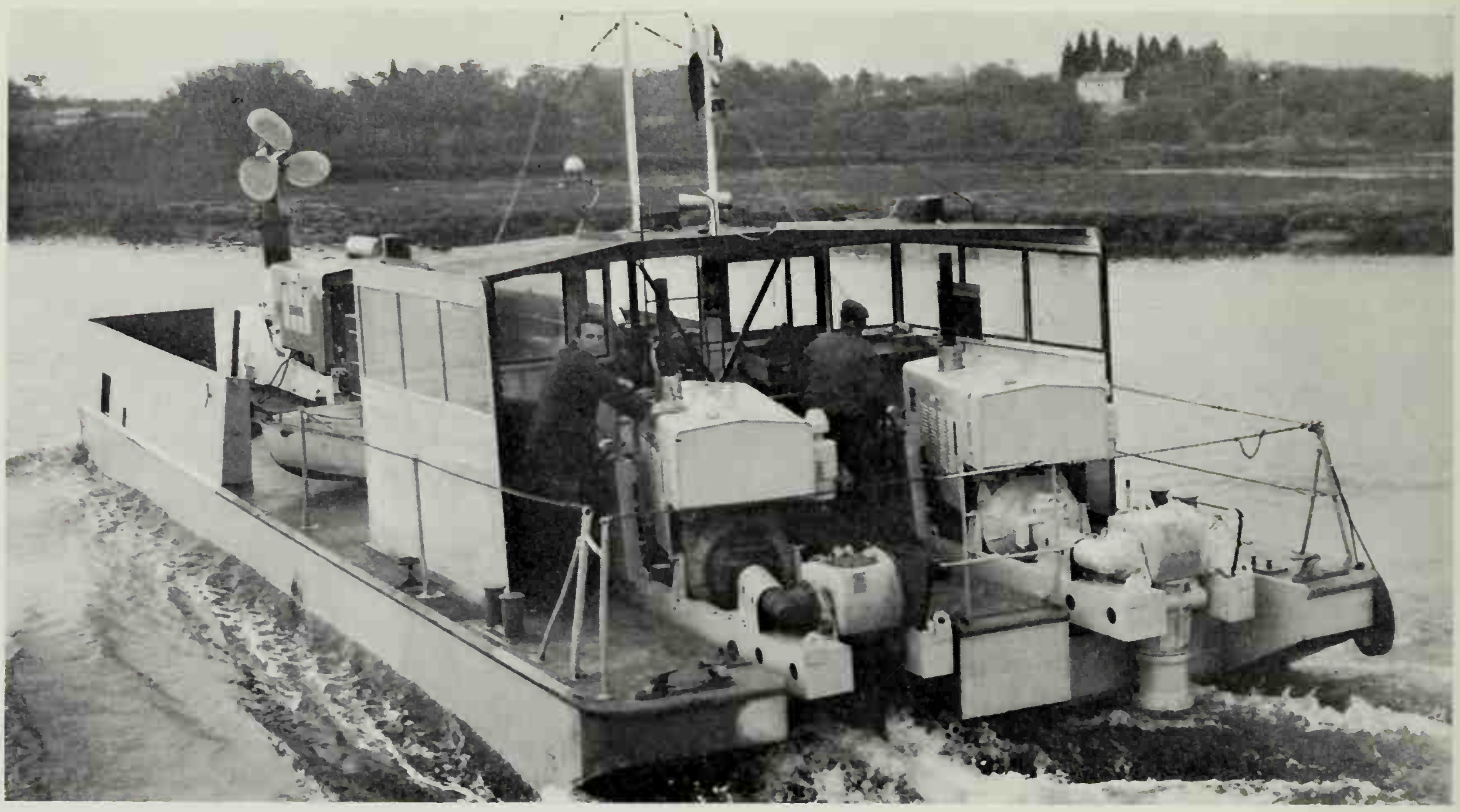

approx. 128 in.
3,251 m.
approx. 168¾ in.
4,28 m.
approx. 126¼ in.
3,207 m.

Main propulsion gear unit for HMS *Exmouth*


approx. 100 in.
2,54 m.
approx. 106¼ in.
2,698 m.
approx. 123 in.
3,124 m.

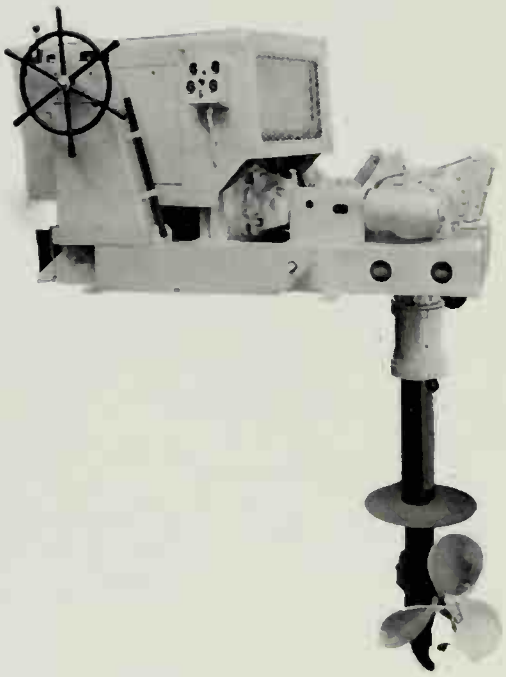
Main propulsion gear unit for Vosper Mk 5 and Mk 7 fast destroyers

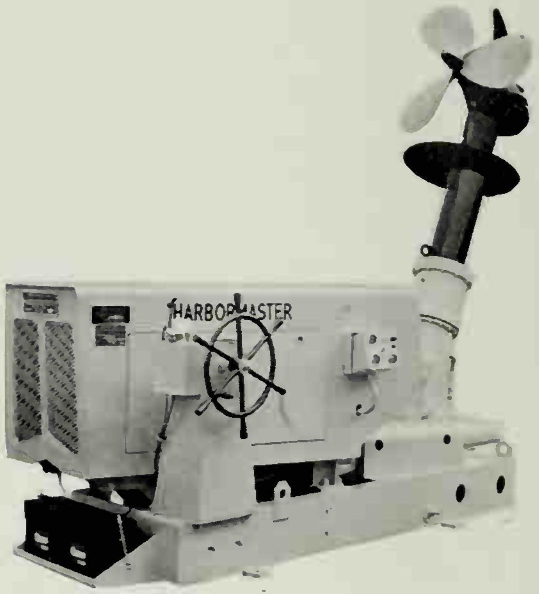
DAVID BROWN GEAR INDUSTRIES LIMITED
Gear Division
Park Gear Works, Huddersfield, Yorkshire, England
Telephone: Huddersfield 22180 Cables: Gearing Huddersfield Telex: 51562

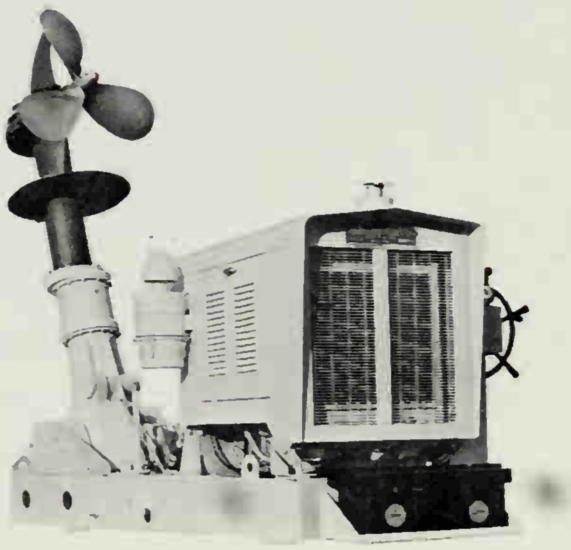


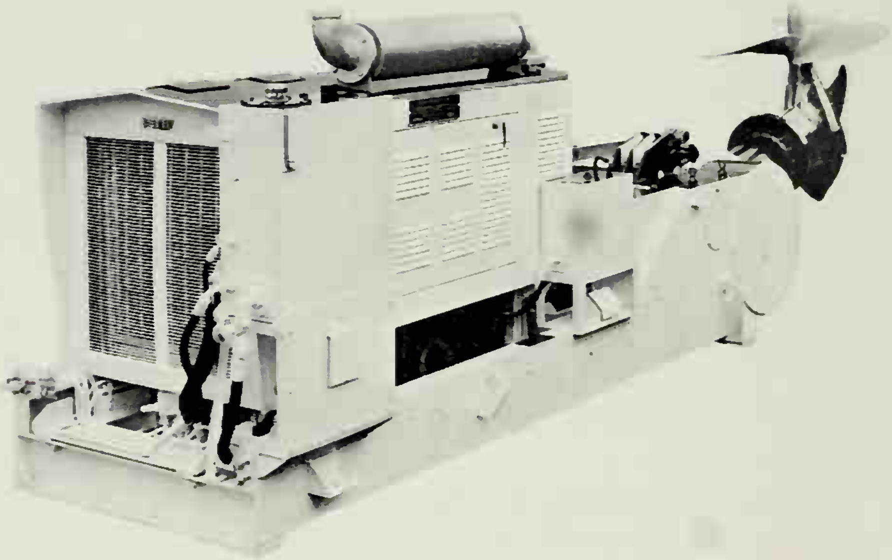
Above: pontoon with two 75 hp units mounted together on the stern. A third unit of 150 hp (stem raised) is mounted on the bow for test purposes. Stem lengths can be varied according to displacement of vessel and working depth of water. The units can be operated by controls mounted on the engine bed or from a remote control for one or more units. Other illustrations show Ford-engined units of 50 hp (right) and 65 hp (far right) with Dorman-engined units of 75 hp (below left) and 150 hp (below right)

Harbormaster units are designed for moving heavy loads at comparatively low speeds under arduous conditions, over long periods of continuous operation with the minimum of maintenance. They are therefore designed to deliver power at a high thrust/hp ratio with the maximum of reliability









Outboard propulsion units

for heavy-duty marine applications

These large outboards provide a powerful and unique type of propulsion for more substantial craft such as tugs. ferries, dredgers, floating cranes and heavy barges. A safety device in the form of a friction slip-gear permits the stem and tail assembly to swing back if underwater obstructions are encountered. The entire unit can be mounted on any craft by simply clamping down the four base lugs to the deck. The units are of robust design, reliable under the most arduous conditions, and are supported by a first-class spares service.

Technical specifications

50 hp

Engine (1)
Ford 2701C four-stroke four-cylinder diesel. 50 bhp at 1850 rev/min for continuous duty. Totally enclosed freshwater cooling with tropical radiator.

Transmission
Borg & Beck overcentre clutch or Borg Warner 1:1 reverse gear driving 737 mm (29 in) dia standard towing propeller through Harbormaster geared transmission. Vertical shaft lengths 1220 mm (4 ft) min, 2135 mm (7 ft) max. Steering through continuous 360 deg. Total weight of unit 1500 kg (1·5 tons). Fuel tank 68 litres (15 gal).

Engine (2)
Dorman 4DA four-stroke four-cylinder air-cooled diesel. 50 bhp at 1850 rev/min for continuous duty.

Transmission
Borg and Beck overcentre clutch or Parsons hydraulically operated 1:1 reverse gear driving a 737 mm (29 in) dia standard towing propeller through Harbormaster geared transmission. Vertical shaft lengths 1220 mm (4 ft) min, 2135 mm (7 ft) max. Steering through continuous 360 deg. Total weight of unit 1500 kg (1·5 tons). Fuel tank 68 litres (15 gal).

65 hp

Engine
Ford 2704C four-stroke six-cylinder diesel. 65 bhp at 1800 rev/min for continuous duty. Totally enclosed freshwater cooling with tropical radiator.

Transmission
Borg Warner hydraulically operated 1:1 reverse gear driving a 965 mm (38 in) dia standard towing propeller through Harbormaster geared transmission. Vertical shaft lengths 1220 mm (4 ft) min, 2135 mm (7 ft) max. Steering through continuous 360 deg. Total weight of unit 2450 kg (2·4 tons). Fuel tank 104 litres (23 gal).

75 hp

Engine
Dorman 4LD four-stroke four-cylinder diesel. 75 bhp at 1800 rev/min for continuous duty. Totally enclosed freshwater cooling with tropical radiator.

Transmission
Parsons hydraulically operated 1:1 reverse gear driving a 965 mm (38 in) dia standard towing propeller through Harbormaster geared transmission, Vertical shaft lengths 1220 mm (4 ft) min, 2135 mm (7 ft) max. Steering through continuous 360 deg. Total weight of unit 2850 kg (2·8 tons). Fuel tank 135 litres (30 gal).

150 hp

Engine
Dorman 6LDT four-stroke six-cylinder turbo-charged diesel. 150 bhp at 1550 rev/min for continuous duty. Totally enclosed fresh-water cooling with tropical radiator.

Transmission
Borg & Beck overcentre clutch driving a 1270 mm (50 in) dia standard towing propeller through Harbormaster geared transmission. Vertical shaft lengths 1520 mm (5 ft) min, 2440 mm (8 ft) max. Steering through continuous 360 deg. Total weight of unit 5700 kg (5·6 tons). Fuel tank not included in supply.

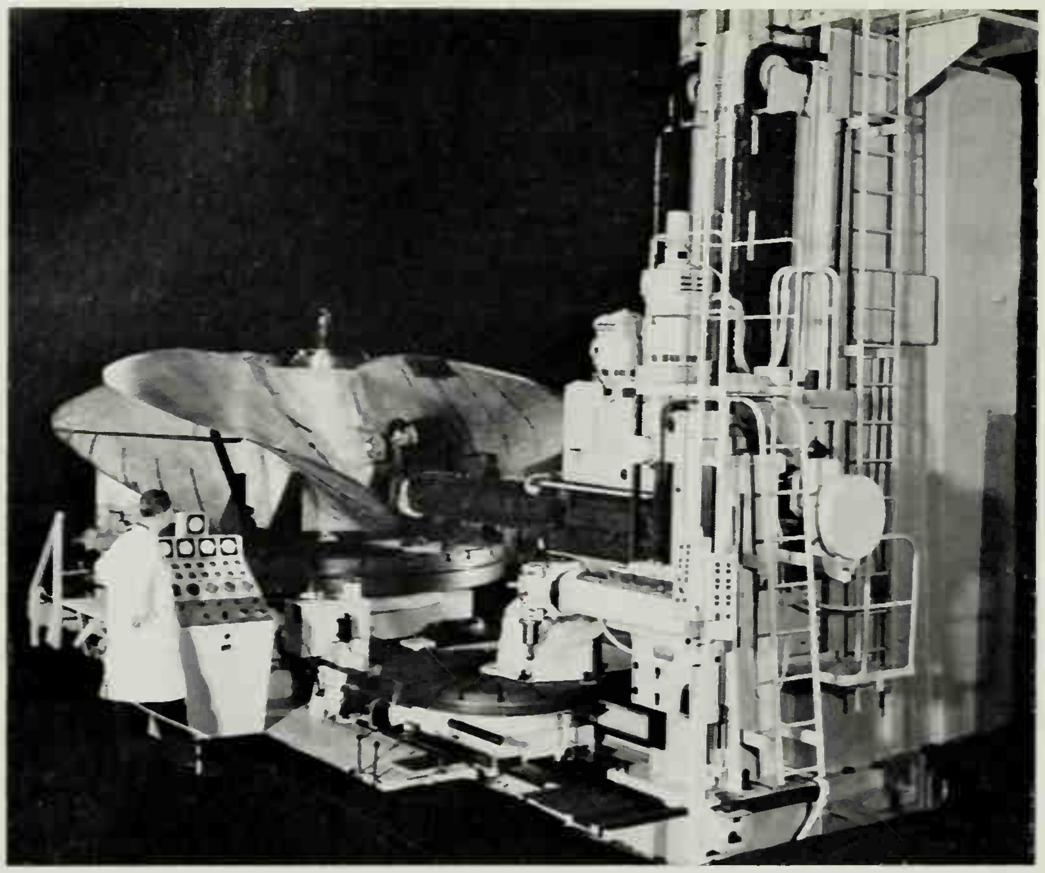
Remote control
Harbormaster units can be operated by the controls on the unit or, if necessary, from a remote position with mechanical, hydraulic or electro-hydraulic controls. Where a multiple unit installation is required, control can be achieved by variations of the above methods.

50 hp, 65 hp and 75 hp units
Pedestal-type control columns are available for remote control of one or more units for steering, throttle and reverse gear, with mechanical steering through lay-shafting.

150 hp units
Control consoles can be supplied for mounting on the bridge or wheelhouse, to accept the electro-hydraulic controls which are supplied as an integral part of the 150 hp unit.

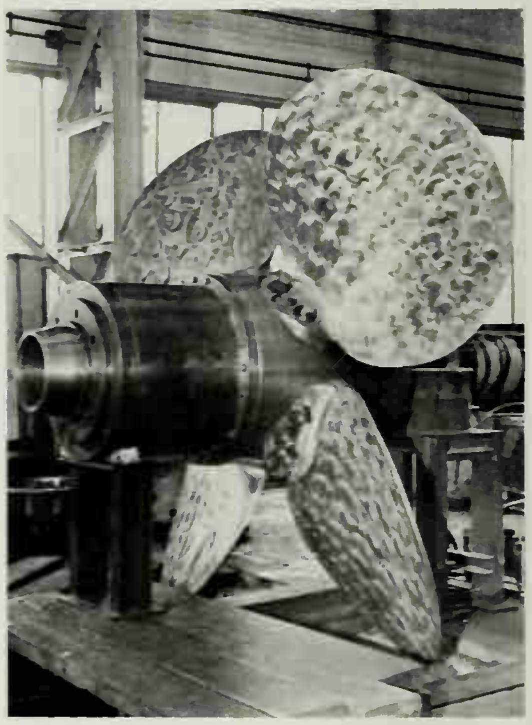
HARBORMASTER LIMITED
Sales Department
Central Road, Temple Fields, Harlow, Essex, England
Telephone: Harlow 24301 Cables: Jonwhiteng Harlow Telex: 81317

HARBORMASTER

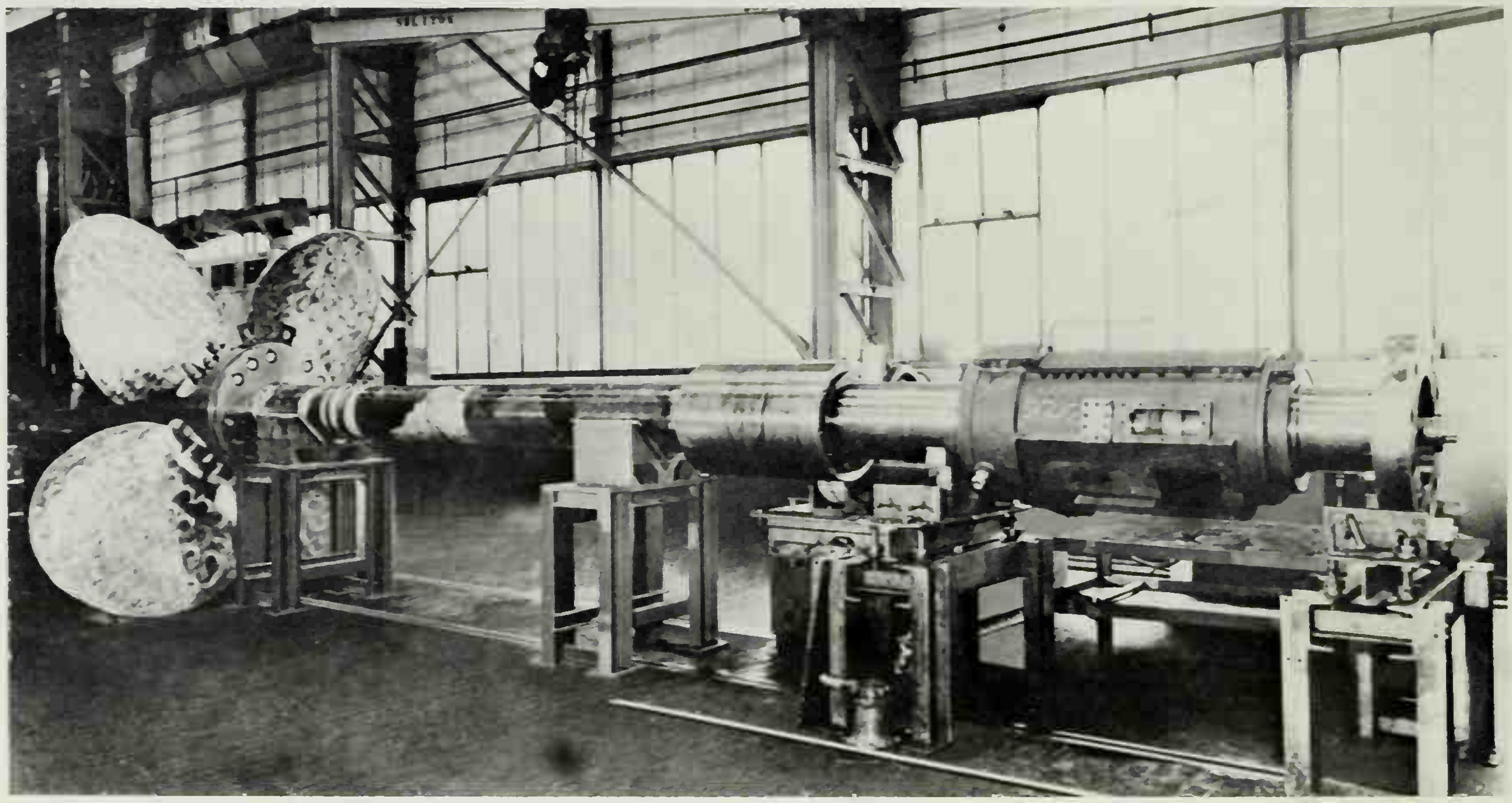


The illustrations on this page show some of the facilities and equipment of SMM used in the production of propellers

Fixed-pitch propellers
Stone Manganese Marine Limited is leading supplier of propulsion equipment to the Royal Navy. The company's Birkenhead Works specialises particularly in this production



Controllable-pitch propellers and bow thrust units
The company provides three designs of controllable-pitch propellers in addition to bow thrust units to meet all naval applications. The SMM Greenwich Works, in which the accompanying photographs were taken, specialises in the production of this equipment

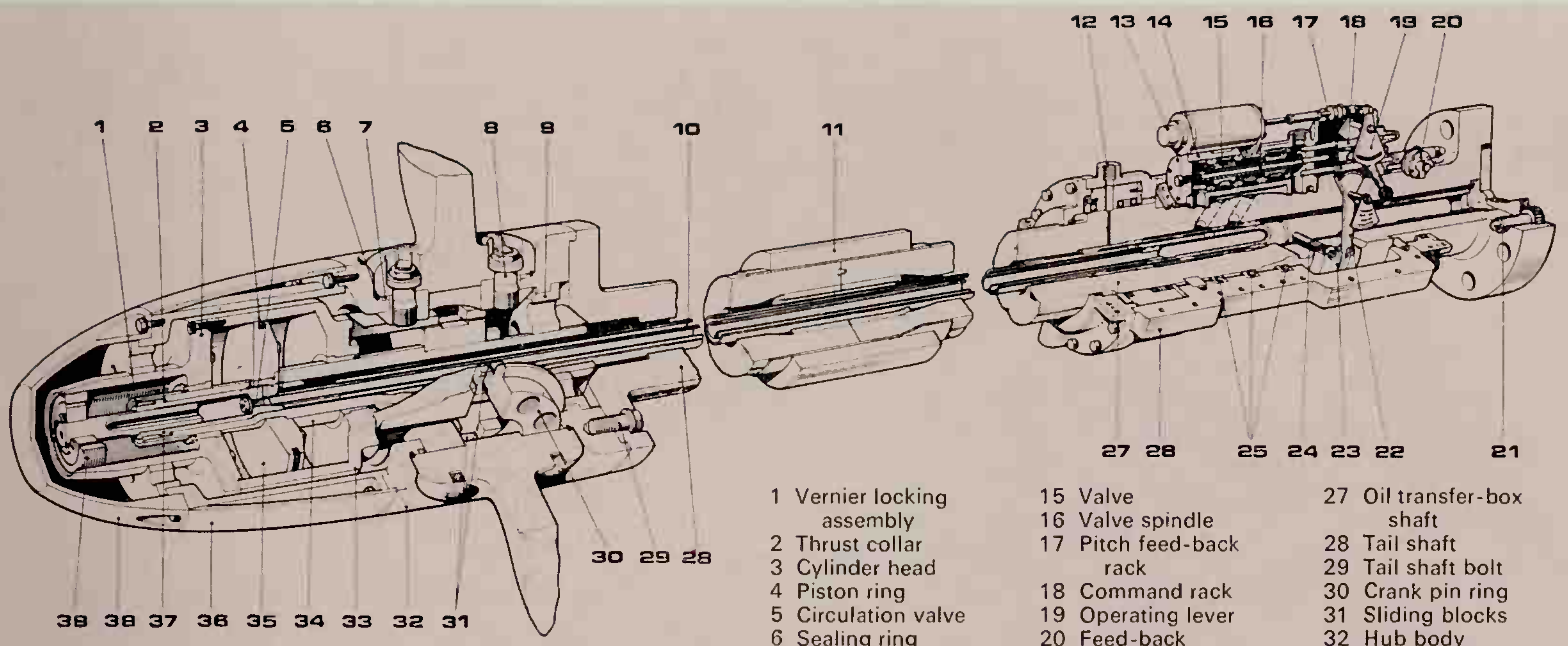


Propellers

for all marine applications

Stone Manganese Marine Limited continues a long history of over a century as main supplier of propulsion equipment to the British Ministry of Defence (Navy).

In this priviliged position, the company continues to develop its range of products and manufacturing facilities to meet fully all requirements of the Royal Navy.



1	Vernier locking assembly
2	Thrust collar
3	Cylinder head
4	Piston ring
5	Circulation valve
6	Sealing ring
7	Bearing ring
8	Blade bolt
9	Piston rod bearing
10	Pressure tubes
11	Shaft coupling
12	Header tank connection
13	Pneumatic actuator
14	Valve casing
15	Valve
16	Valve spindle
17	Pitch feed-back rack
18	Command rack
19	Operating lever
20	Feed-back transmitter
21	Pitch locking device
22	Feed-back lever
23	Feed-back sliding ring assembly
24	Carrier pin
25	High-pressure seals
26	Oil transfer-box casing
27	Oil transfer-box shaft
28	Tail shaft
29	Tail shaft bolt
30	Crank pin ring
31	Sliding blocks
32	Hub body
33	Servo cylinder
34	Piston rod
35	Servo piston
36	Cone
37	Driving sleeve
38	Cone cap
39	Jacking screw

Diagramatic arrangement of a Model XX controllable-pitch propeller

High-definition propellers of the types required by the Ministry of Defence involve close manufacturing tolerances both in the casting and machining stages. Adherance to these fine limits is achieved using most modern production techniques, in the three works of SMM at Greenwich, Birkenhead and Glasgow.

SMM has developed a range of alloys which have been adopted for use by the Ministry of Defence (Navy)—these include Superston Seventy, Novoston and the new sound-deadening alloy Sonoston.

The range of propulsion equipment supplied for naval applications—fixed-pitch and controllable-pitch propellers and bow thrust units—is supported by other specialised equipment in this field, including watertight door and fire-door systems as well as marine windows.

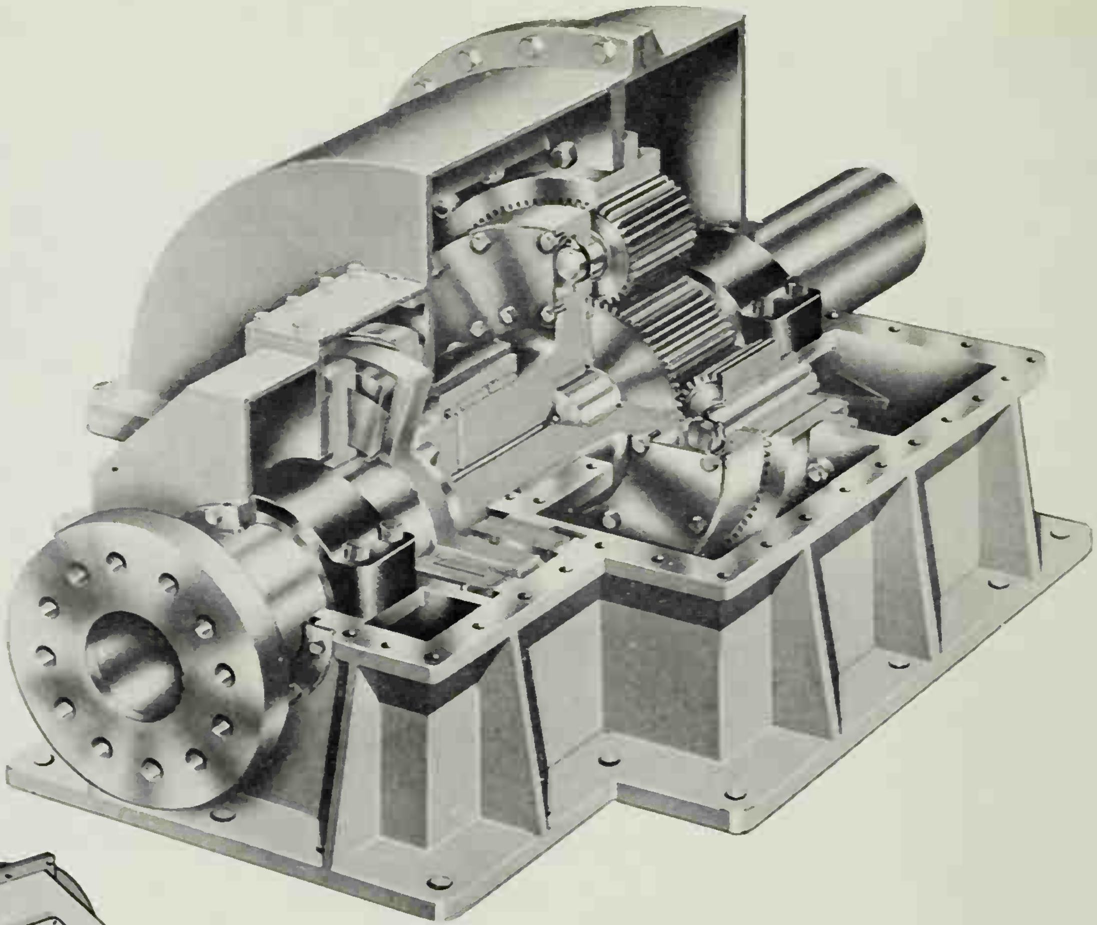
From the Glasgow Works foundry SMM supplies non-ferrous castings in a variety of intricate patterns for naval applications.

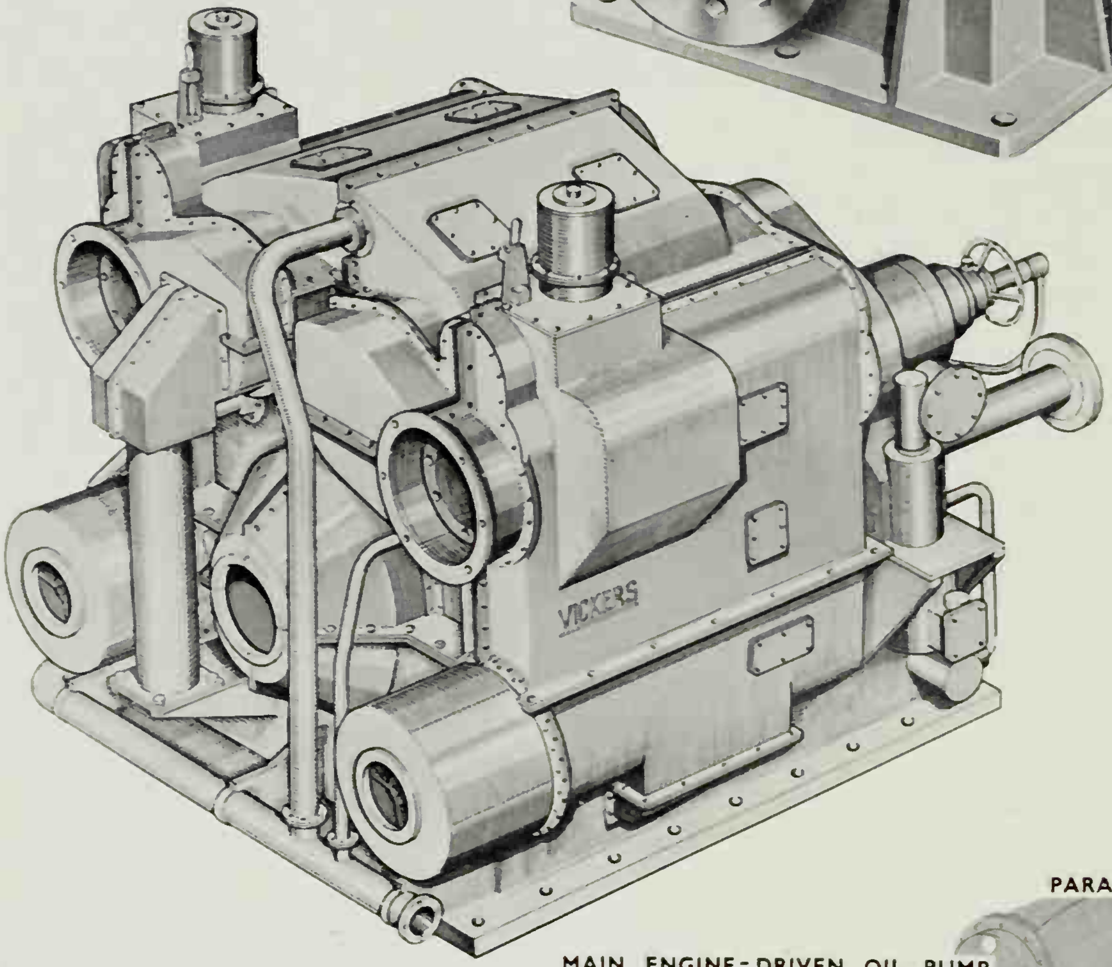
STONE MANGANESE MARINE LIMITED
Anchor and Hope Lane, London SE7, England
Telephone: 01-858 6171

1966
1969

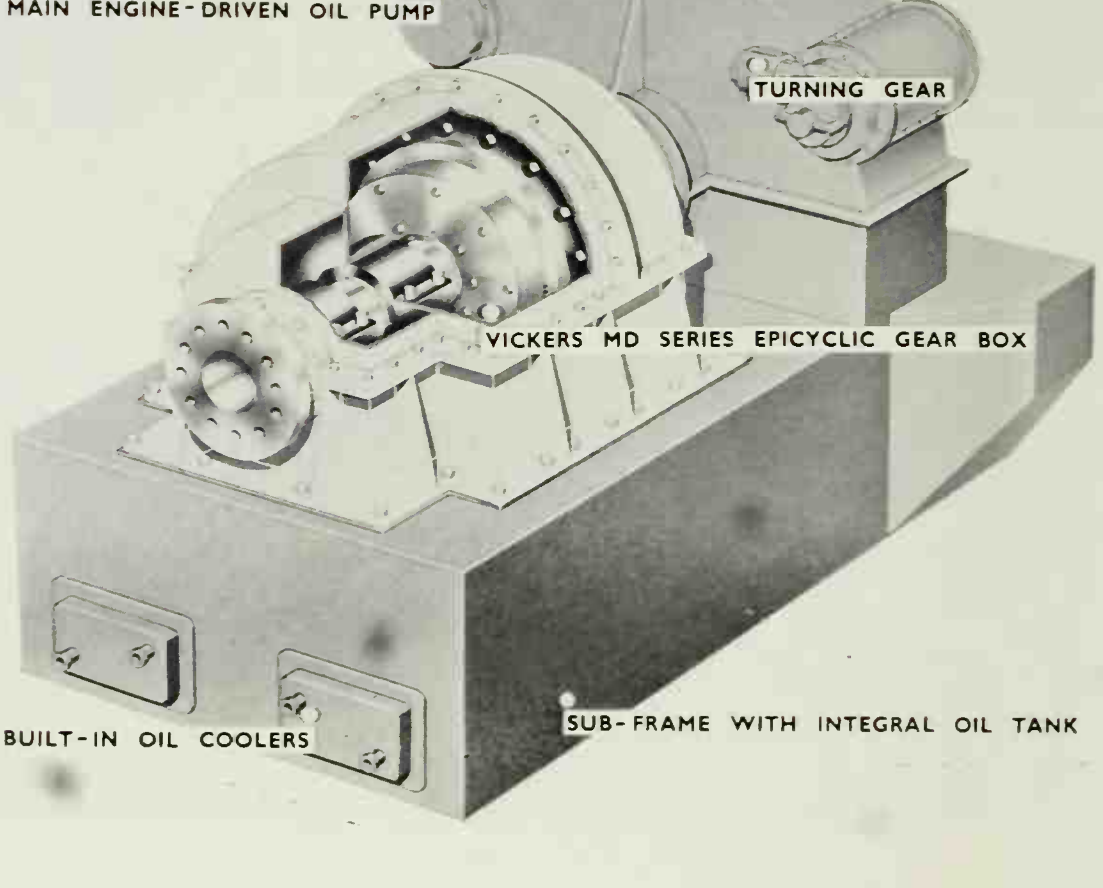
Section 5: Propulsion and auxiliary machinery

A new range of co-axial reduction gears for diesel installations up to 18 000 hp. These incorporate the Vickers epicyclic gear and ratios up to 9:1 are available. The small size and low weight make them especially suitable for modern high-speed ships





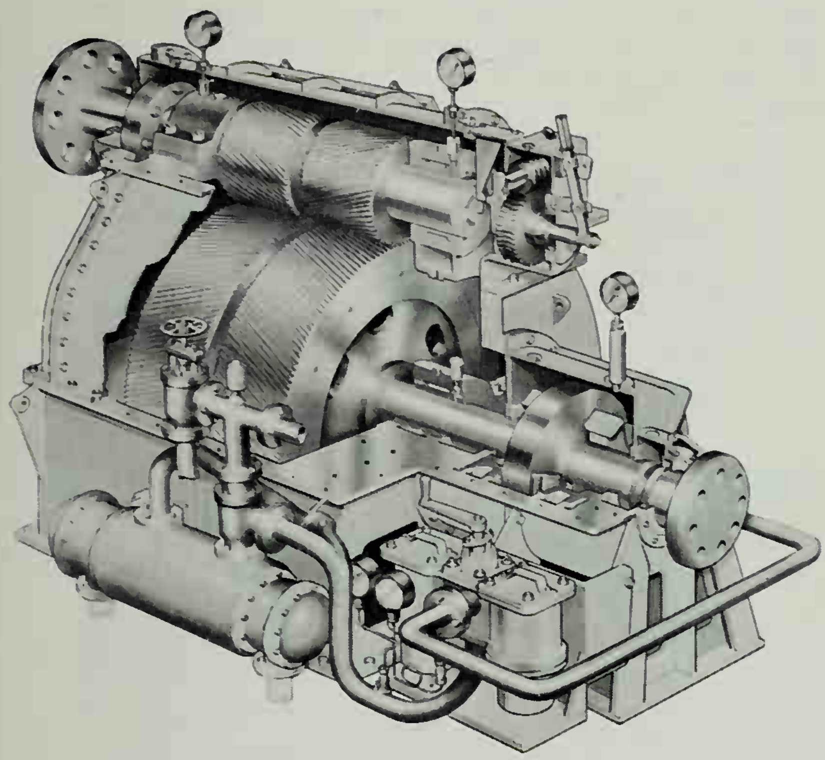
The increasing use of marine gas turbines has led to the development of a new range of gearboxes incorporating synchro self-shifting clutches and flexible couplings so arranged that the main engine can take the drive from the cruise engine without stopping the ship and to provide a smooth take-up of power from rest and during change-over of the engines. Vickers has a range of designs to suit all combinations of gas/steam/diesel prime movers. The design shown is suitable for main gas turbines and cruising diesel engines


PARALLEL-SHAFT PRIMARY REDUCTION
MAIN ENGINE-DRIVEN OIL PUMP
TURNING GEAR
VICKERS MD SERIES EPICYCLIC GEAR BOX
SUB-FRAME WITH INTEGRAL OIL TANK
BUILT-IN OIL COOLERS

A modular design suitable for multiple-input main propulsion machinery incorporating the Vickers epicyclic gear for the final reduction stage

Main propulsion gearing

for naval and marine vessels

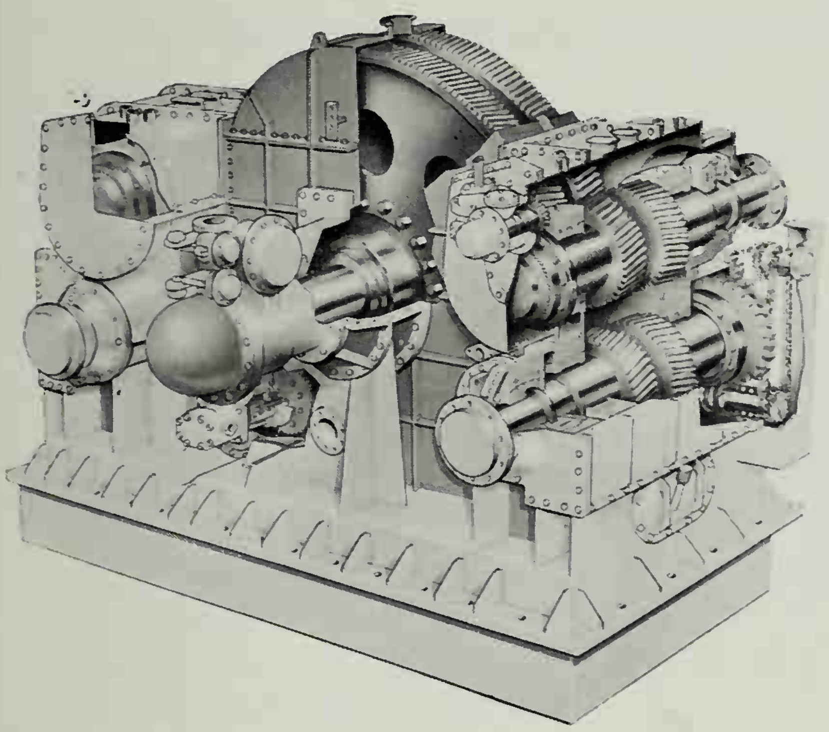


A vertically off-set gearbox for a diesel engine rated at 1700 hp with an input of 900 rev/min and an output of 300 rev/min. The design incorporates a thrust bearing and lubricating oil modules

Vickers marine main propulsion gears have earned an unrivalled reputation for reliability, quiet operation, compactness and ease of maintenance with merchant and naval engineers throughout the world. This reputation can be attributed to the company's policy of continual research and development into manufacturing accuracy, hardening techniques, bearings and gear case design. Vickers association with the British Ministry of Defence (Navy) through the Royal Navy and Vickers Gearing Research Association is continuing to provide fundamental research into all aspects of gear design and manufacture.

In comparison with conventional designs of marine gearing, epicyclic gears overcome size and weight limitations. The Vickers epicyclic gear, incorporating improved load-sharing principles, is now available for marine applications using diesel or turbine main propulsion machinery.

The examples illustrated give an indication of the designs available for all forms of main propulsion machinery.



A single-reduction double-helical gearbox to take the drive from four 2000 hp engines. Control equipment for a controllable-pitch propeller is fitted to the forward end of the gearbox. The design can be modified to suit two or three engines and power-takeoffs for pumps and generators can be provided

VICKERS LIMITED
Barrow Engineering Works
PO Box 12, Barrow-in-Furness, Lancashire, England
Telephone: Barrow-in-Furness 3366 Cables: Vickerseng Barrow-in-Furness
Telex: 6597

Vickers

Disc brakes

for marine main propulsion transmissions

Dunlop Aviation Division, with long experience in advanced brake design for aircraft and other applications, was first brought into the marine brake field in January 1966, with the conversion of HMS *Exmouth* to all-gas-turbine propulsion.

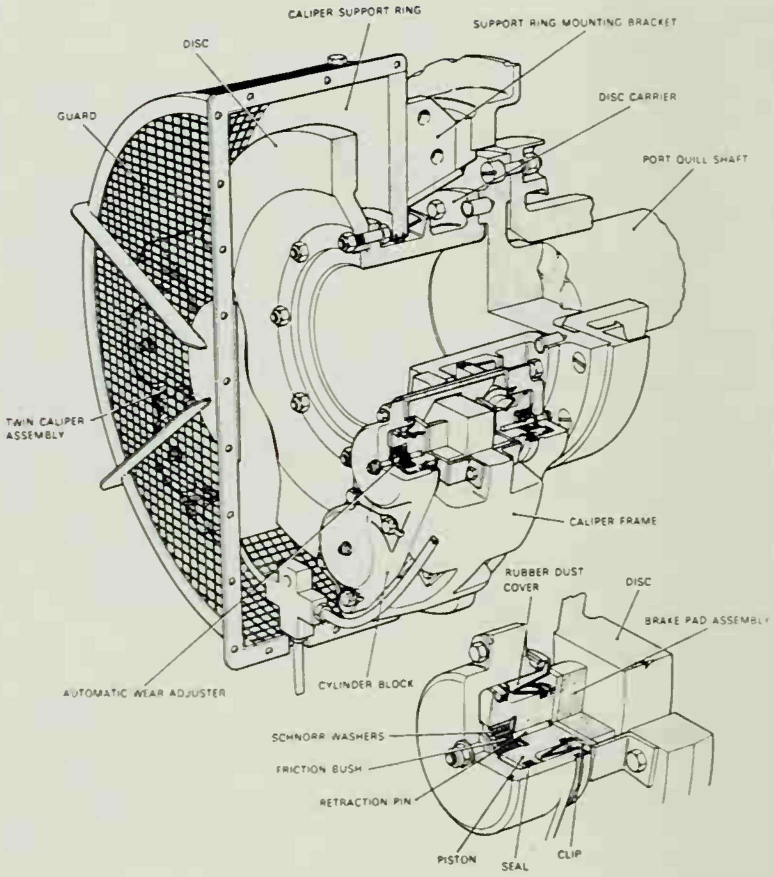
The Dunlop brake, as installed in HMS *Exmouth*, consists of a single chromium-plated copper disc and two castiron calipers. Operation of the brake is by a total of eight pistons applying load pneumatically on to the same number of organic friction-pad assemblies.

The success of this first installation has led to Dunlop brakes being adopted for the Type 42 GW destroyer and the Type 21 frigate, in these cases three calipers being used instead of two.

Brakes suitable for use with reversing gearboxes or with controllable pitch propellers, in conjunction with any current marinised gas-turbine power plant, can be designed and supplied.

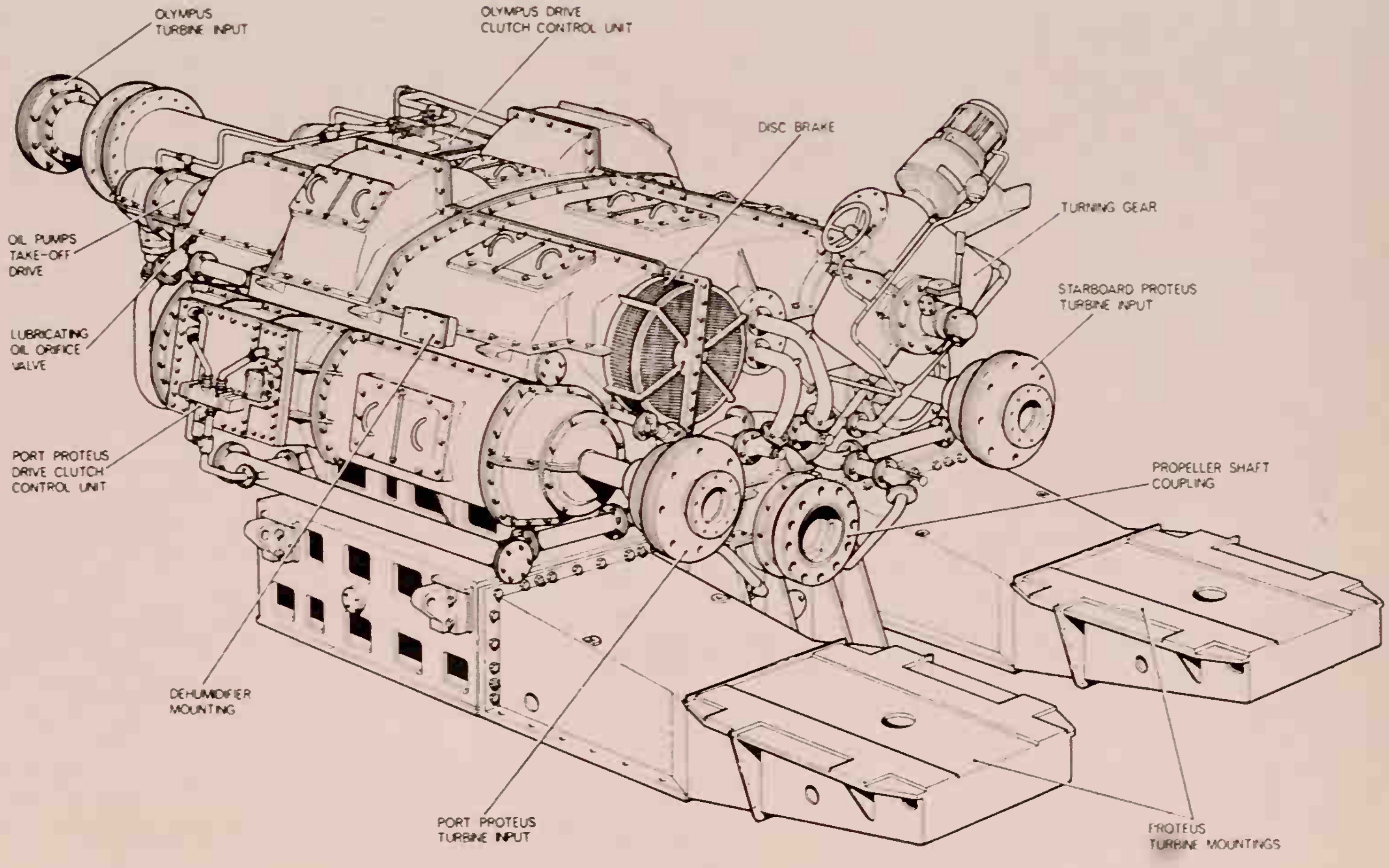
To enable Dunlop to design a suitable brake installation, the following information would be required:

Torque requirements
Energy requirements
Dimensions
Operating pressure available
Stopping time
Frequency of operation
Rubbing speed
Life required


CALIPER SUPPORT RING
SUPPORT RING MOUNTING BRACKET
DISC
DISC CARRIER
GUARD
PORT QUILL SHAFT
TWIN CALIPER ASSEMBLY
CALIPER FRAME
RUBBER DUST COVER
DISC
BRAKE PAD ASSEMBLY
AUTOMATIC WEAR ADJUSTER
CYLINDER BLOCK
SCHNORR WASHERS
FRICTION BUSH
RETRACTION PIN
PISTON
SEAL
CLIP

Above: Dunlop disc brake for HMS *Exmouth*

Below: Main gearing of HMS *Exmouth* viewed from aft


OLYMPUS TURBINE INPUT
OLYMPUS DRIVE CLUTCH CONTROL UNIT
DISC BRAKE
TURNING GEAR
OIL PUMPS TAKE-OFF DRIVE
STARBOARD PROTEUS TURBINE INPUT
LUBRICATING OIL ORIFICE VALVE
PORT PROTEUS DRIVE CLUTCH CONTROL UNIT
PROPELLER SHAFT COUPLING
DEHUMIDIFIER MOUNTING
PORT PROTEUS TURBINE INPUT
PROTEUS TURBINE MOUNTINGS

THE DUNLOP COMPANY LIMITED
Aviation Division—Military Equipment Sales
Holbrook Lane, Coventry, CV6 4AA, England
Telephone: Coventry 88733 Cables: Sound Coventry Telex: 31677

1968

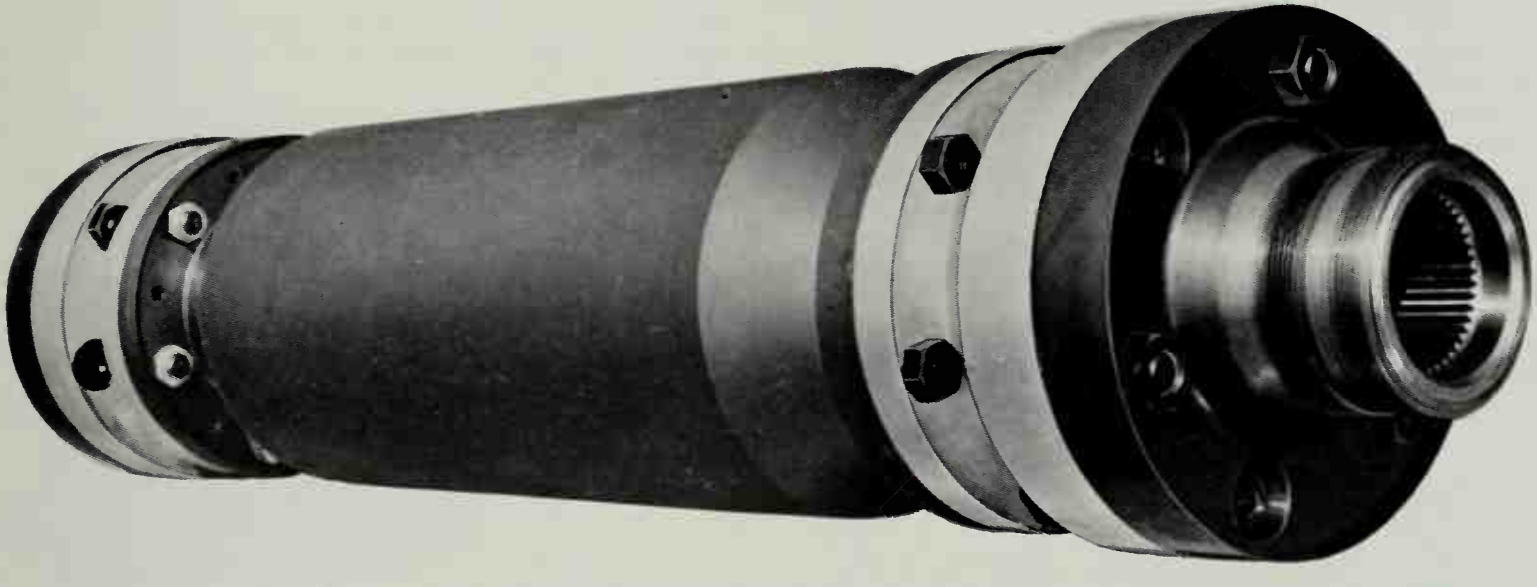
Flexible couplings

for marine main propulsion machinery

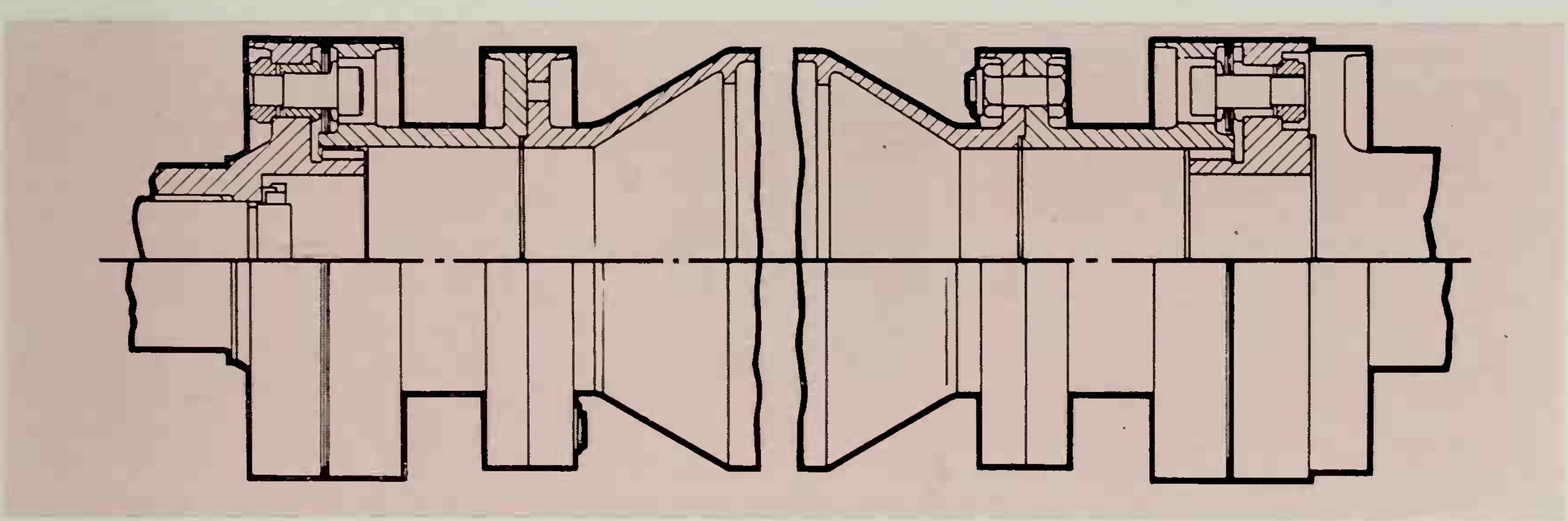
Metastream main propulsion couplings are being fitted to Type 42 machinery for the next generation of fighting ships. They accommodate misalignment due to thermal expansion, hull flexure and distortion from underwater shock. The non-lubricated dry couplings maintain their high degree of dynamic balance, minimising vibration at high speed and under arduous conditions.

The couplings are of the non-lubricated type and are available in a wide range of sizes to transmit any required torque. Dynamic balance is retained even under considerable misalignment, ensuring internally vibration-free operation.

Metastream couplings are designed to operate at high speed under arduous conditions and are therefore ideal for marine gas turbine propulsion. The world's first all-gas-turbine major warship, HMS *Exmouth*, uses Metastream couplings in her main propulsion machinery comprising two Proteus and one Olympus gas turbines.



General view of a typical Metastream coupling for marine main propulsion, especially for vessels powered by marine gas turbine engines



Sectional view of typical Metastream coupling, showing method of attachment at both ends. The degree of flexibility attainable with this design is dependent on the overall length between flexing members

Metastream flexible couplings are also used in:
Royal Navy: GP frigates (one gas and one steam turbine):
HMS *Zulu, Nubian, Gurkha, Eskimo, Tartar, Ashanti, Mohawk.*
GM destroyers (four gas and four steam turbines):
HMS *London, Hampshire, Kent, Devonshire, Fife, Glamorgan*
Type 82 destroyer (two steam and gas turbines):
HMS *Bristol*
Iranian Navy: Mark 5 frigates (gas turbine)
Libyan Navy: Mark 7 frigates (gas turbine)
Malaysian Navy: Yarrow frigate (gas turbine)
Metastream couplings are available direct from Flexibox companies established in many parts of the world

FLEXIBOX LIMITED
Nash Road, Trafford Park, Manchester, M17 1SS, England
Telephone: 061-998 7000 Telex: 66284

METASTREAM

Main machinery controls

for naval vessels

Vosper Electric has for many years been involved in the design and development of control and instrumentation systems for gas turbine and diesel engines used in naval vessels.

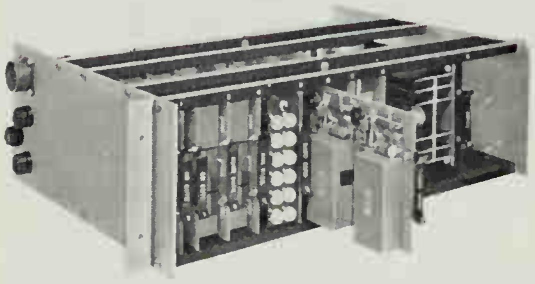
The latest developments are a solid-state digital sequence control system and motor starting unit for use with gas turbine engines, and a power pitch control system which includes single-lever control of diesel and gas turbine main machinery and controllable pitch propellers.

The gas turbine starter and control equipment has been installed by the Vosper Thornycroft Group in three fast patrol craft being built for the British Ministry of Defence, also the Group's fast patrol boat *Tenacity*. Similar equipment is also installed in the BH. 7 hovercraft built by the British Hovercraft Corporation for use by the Ministry of Defence.

The power pitch control system is under consideration for use in the Type 21 frigate being designed and built by the Vosper Thornycroft Group for the Ministry of Defence. A similar system has already been installed and has undergone successful sea trials in the Iranian Mk 5 frigate.

The sequential control units and motor starter units may be used independently of each other; the sequential control unit can be used with an airstart engine.

Digital sequential control unit Type D.200860



Pressing the starting push initiates a sequence of operations (opening fuel valves, starting pumps, etc) and actuating the starting unit.

The availability of these essential conditions is checked automatically. The absence of any of these conditions prevents the continuation of the sequence and provides an alarm signal. Any turbine running fault conditions (excessive exhaust temperature, low lubricating oil pressure, etc.) automatically shuts down the engine, gives an alarm and indicates the nature of the fault. Delay devices avoid unnecessary shut-downs on transient signals where applicable and also provide a fail-to-start indication (sounding an alarm if necessary) or initiate a new starting cycle any predetermined number of times.

Proteus gas turbine starter unit Type D.135828

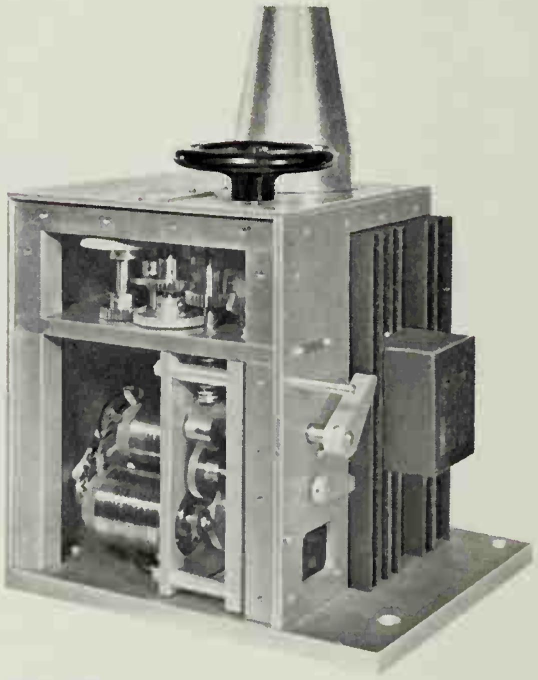
This unit is capable of delivering a high starting torque which is readily adjustable over a wide range, thus making the starter suitable for starting engines having differing characteristics. Once set, the cycling sequence is repeatable to within 1 percent, thus preventing damage to the starter motor or engine.

The power supplies to the starter unit are 115 V, three-phase, 50 or 400 Hz. Other supplies can be considered.

When a start signal is received at the thyristor timing module from the digital sequential control unit, the thyristor diode bridge is switched on and current flows through the starter. As the firing angle is increased, more current flows and the starter motor accelerates. When sufficient speed has been achieved the engine firing button can be actuated and the engine ignites. As the engine accelerates, the current through the starter falls and the current-sensing device passes a signal to the thyristor firing module, which cuts off the signal to the thyristor diode bridge and hence current to the starter motor. At the same time a signal is passed to the protection and monitoring control module which returns the starter to the ready-for-start position.

Power pitch controls

This system was designed to meet the requirements for a single-lever control of main and cruising engines and controllable-pitch propellers. With very little modification, the system can be used on single-engine installations, installations having fixed-pitch propellers, those having only one control position, also installations which require each engine set to be controlled by individual levers.

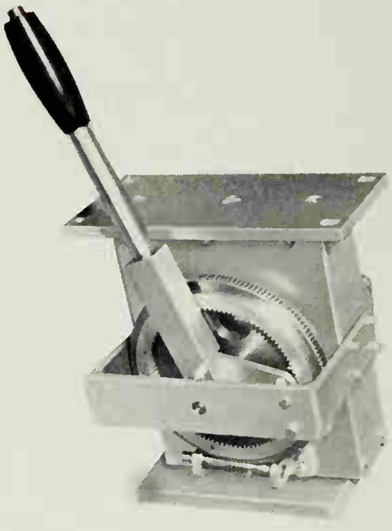


Advantages

A greater degree of automation can be employed; there are virtually no transmission lags, equipment is readily accessible and rapidly repaired, and incorporates failure survival measures. Being set to fail safe, the control units are smaller than their hydro-mechanical or pneumatic counterparts, and cabling at a low current level replaces transmission piping.

Power supplies

115 V single-phase 400 Hz (alternatively 60 Hz) or 28 V stabilised dc.



VOSPER ELECTRIC
Industrial and Marine Controls Division
Castle Trading Estate, Portchester, Fareham, Hampshire, England
Telephone: Cosham 79481 Telex: 86115

1966
1969

Ships' stabiliser

non-retractable fin-type

Since 1955, when the first ship was fitted with Vosper non-retractable fin stabilisers, the system has gained rapidly in popularity and reputation. By the end of 1969 no less than 450 ships varying in displacement from 24 tons to 10 000 tons have been fitted with the equipment. Further development has resulted in the production of systems for ships displacing up to 15 000 tons.

The equipment has been ordered for some 130 warships of different navies including 13 Leander Class frigates as well as the new Mk 5 and Mk 7 fast destroyers.

Advantages

The efficiency of the Vosper system in roll stabilisation is comparable to or greater than that achieved with any other stabiliser system.

It has low weight and space requirements, allowing it to be readily installed in existing or new ships.

Low initial cost and general simplicity make the equipment the most economical to install in relation to performance achieved.

It is simple and automatic in operation and has low running and maintenance costs.

Vulnerability

The fins are designed to be located within the ship's block section so that they do not protrude beyond the maximum beam or keel, thus avoiding any damage when the ship is alongside.

Installation

Vosper non-retractable fin stabilisers are easily installed in an existing vessel since little space need be found within the hull. No great modification is required to the hull and most of the equipment can be installed with the ship afloat.

Multiple fin installations can be provided if required. The control panel is normally mounted in the bridge console; the gyro unit can be mounted in any convenient position. All interconnections between gyro unit, control panel and main stabiliser unit are electrical cable runs, thus eliminating all mechanical linkages.

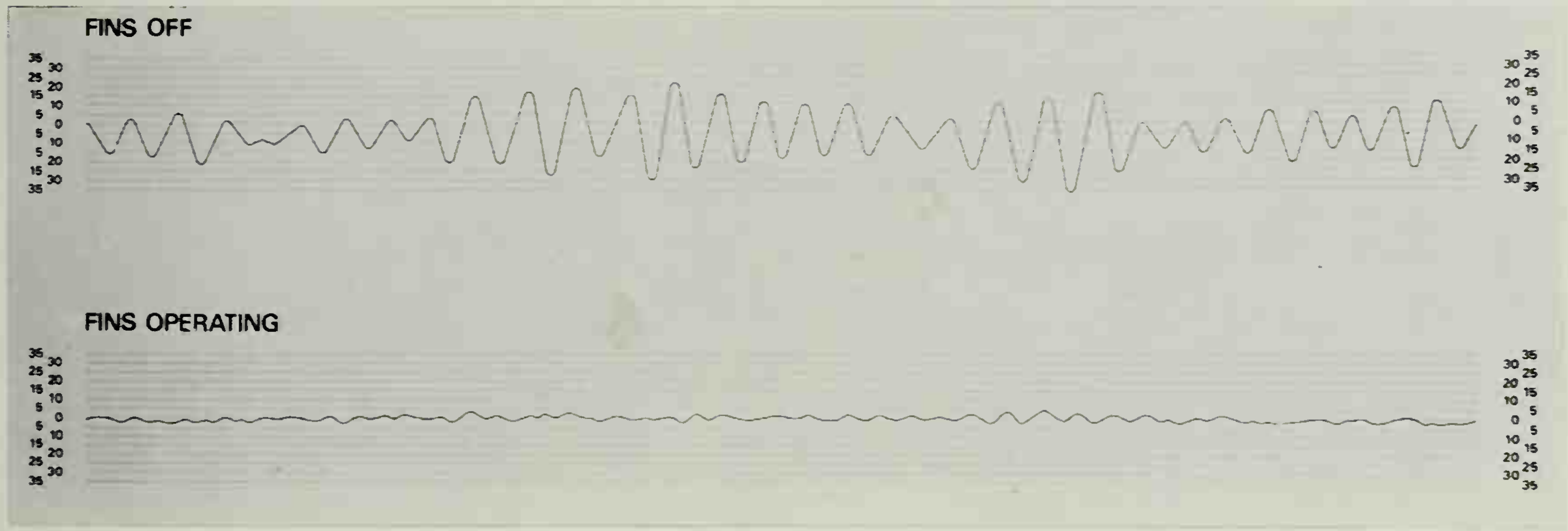
Mk 5 fast frigate fitted with Vosper stabilisers

Performance

It has been found that the provision of a 5° wave slope capacity is adequate to cover the range of wave slopes and associated frequencies which are encountered in practice at sea. Activated fin systems can easily be designed to achieve a 5° wave slope capacity and all Vosper stabilising equipments are so designed. Thus, except in the most violent weather, the stabilising system can compete with the external forces tending to roll the ship and the roll is damped to its normal residual value which is of the order of 3°.

Active fin systems are controlled by signals generated by a gyro unit which is sensitive to the ship's rolling velocity or angular movement. In the more sophisticated systems for larger ships, a composite signal may be used. This is generated from a combination of the ship's angle of heel, roll velocity and roll acceleration. In either case, the sensitivity of the gyro and the characteristics of the hydraulic system are matched so that the fins provide an almost instantaneous correction at any rolling moment induced in the ship.

Roll records taken on board MY *Sea Victory* under gale force 9 conditions



VOSPER THORNYCROFT ENGINEERING
Hydraulic Power Division
Paulsgrove, Portsmouth, Hampshire, England
Telephone: Cosham 79481 Telex: 86115

1966
1969

Ships' line shaft bearings

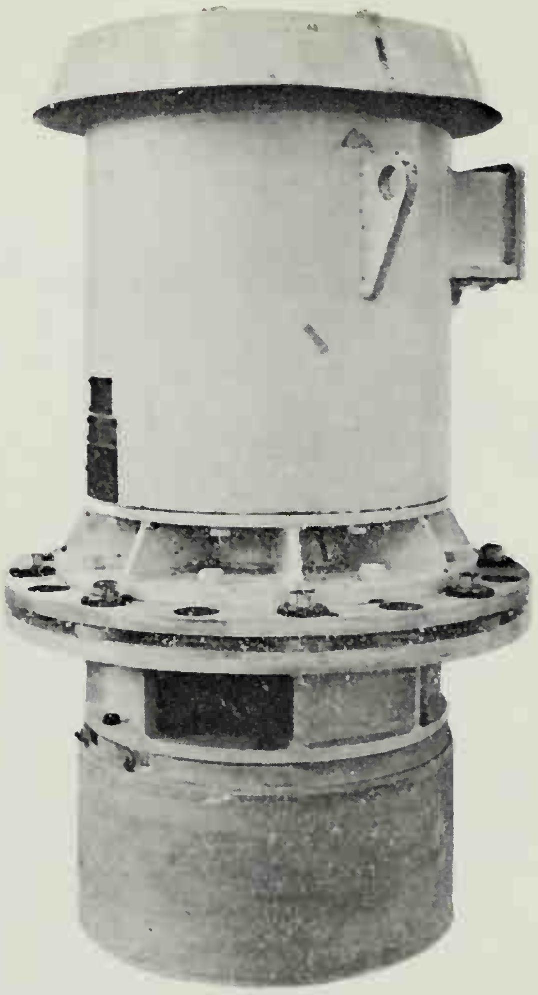
The Glacier-Herbert Sterngear System allows inspection and replacement of outboard seal and stern tube bearing in a loaded ship at sea without dismantling the shaft or removing the propeller. Additional operational advantages are:

1. Better load distribution with scope to control 'whirling' by providing alignment adjustment to the shaft under load.
2. The propeller can be changed quickly without dismantling any other element of the sterngear.
3. The bearing assembly can be adapted to a constant-pitch propeller, reducing propeller removal charges during dry-docking.
4. In a built-up propeller arrangement, facilities are available for rapid blade replacement, even with the propeller submerged.

The Glacier Metal Co Ltd
Alperton, Wembley, Middlesex, HA0 1HD, England
Telephone: 01-997 6611
Cables: Glamet Wembley
Telex: 936881

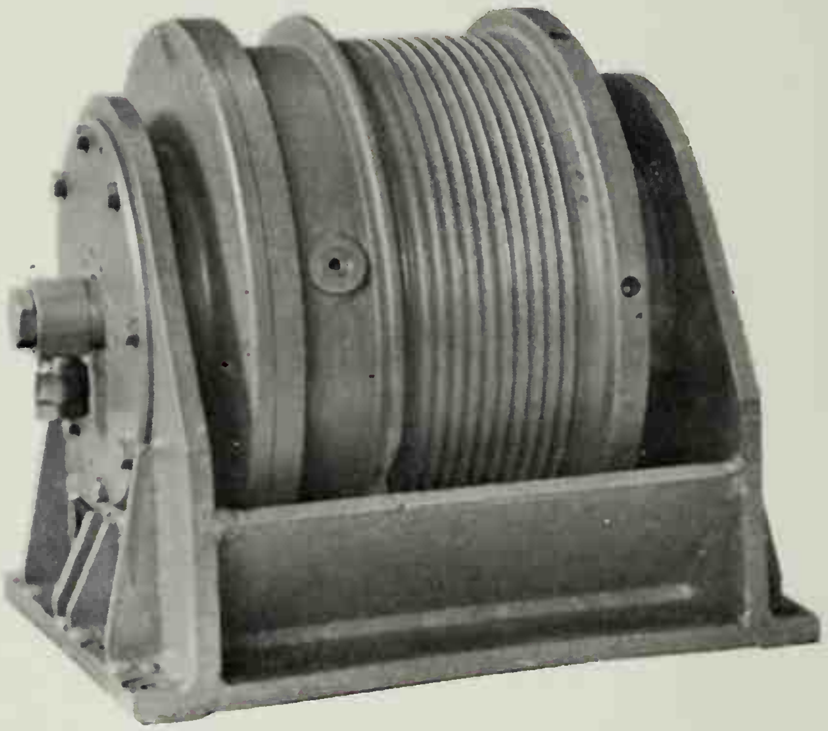
Section 6

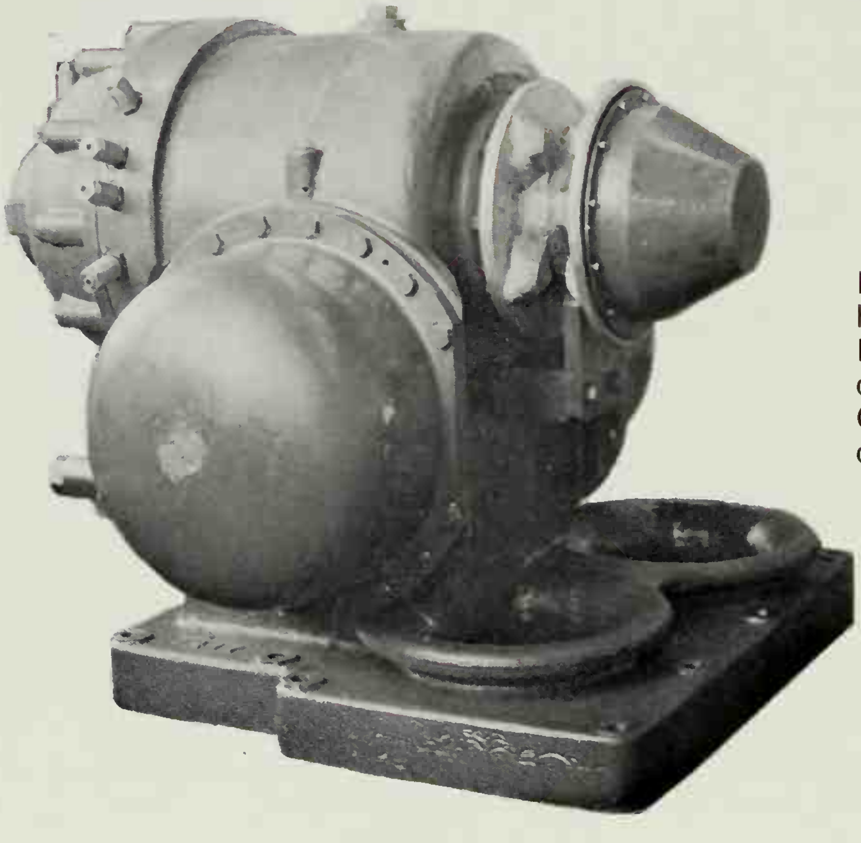
Other naval equipment



Left: Typical MacTaggart Scott radial high-pressure oil pump. Output ranges up to 200 litres/min (44gal/min) and pressures up to 500kg/cm^2 (7111lb/in^2). They can be assembled into extremely compact units and are used for powering many types of hydraulic system. Similar pumps, designed for extreme silence in operation, are fitted to all classes of HM submarines.

Right: Weapons-handling winch with high-torque hydraulic motor contained within drum for compactness and weight saving. Unit fitted with multi-disc hydraulically released brake. All working parts immersed in oil.





Left: Submersible anchor gears with twin high-torque hydraulic motors enclosed within pressure casing. Fitted with multi-disc hydraulically released brake and clutch mechanism. All working parts immersed in oil. Console-mounted control including 'cable-out' indication within hull.

Aircraft arresting gear

The latest optimum energy-absorption, low-reeve arresting gear of a direct-acting valve-operated type is at present under prototype testing by the US Navy.

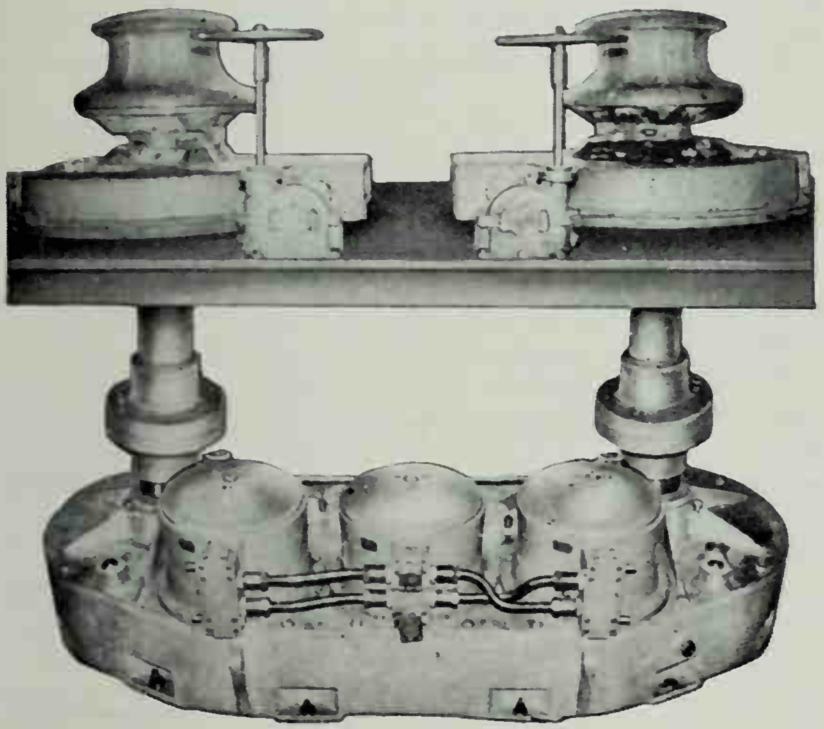
Hydraulic equipment

for naval applications

The use of hydraulic power is widely advocated where safety, flexibility, smooth operation, quietness and extreme compactness are at a premium. Examples of hydraulic equipment specially designed to incorporate these essential features are shown on these pages.

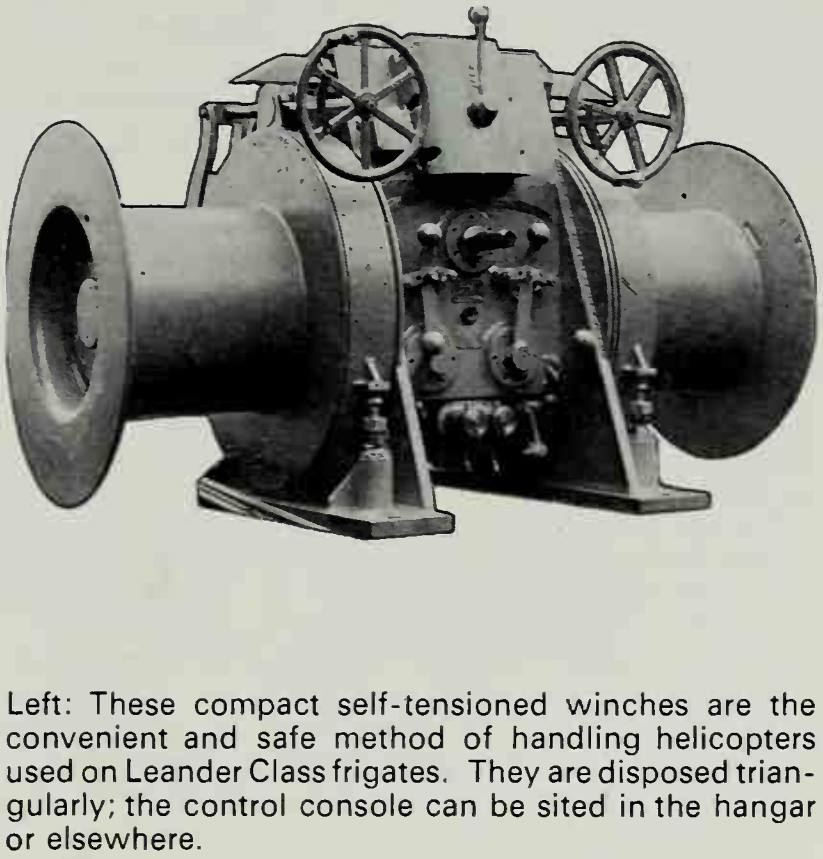
All the units illustrated were designed and manufactured by MacTaggart Scott.

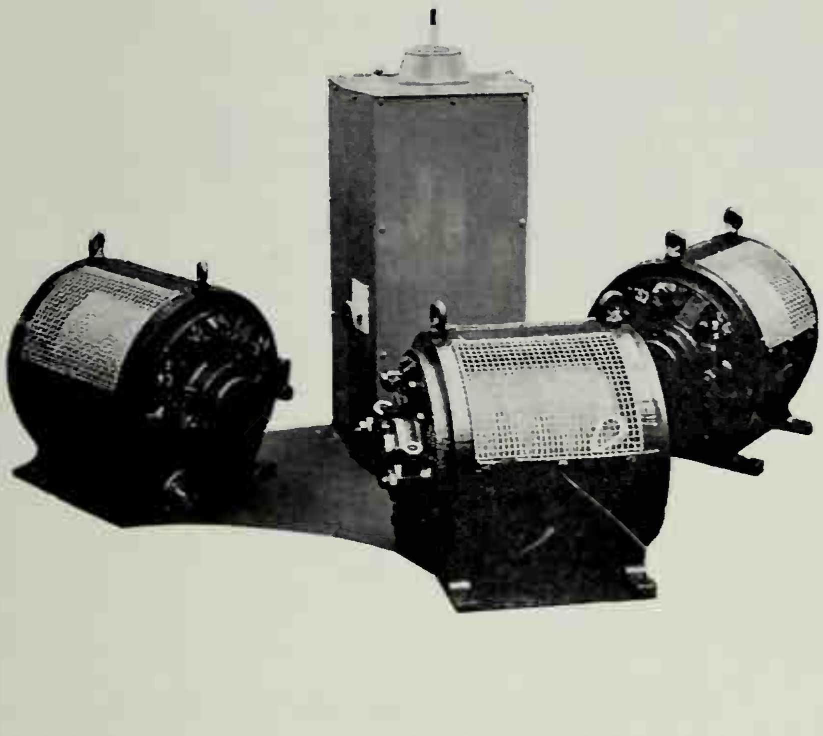
Enquiries are invited on any subject covered by the range of equipment shown in the accompanying pictures, or for similar equipment for the many other naval applications where the advantages listed above are of importance.



Left: The forward anchor gear of a County Class guided missile destroyer. Speed is infinitely variable from zero to 22m/min (70ft/min). This anchor gear can exert chain loads of 50 tons at slow speeds down to 7 tons at maximum speed. Variations allow separate gearboxes or, for smaller capstan units, direct drive from a motor incorporated entirely above deck within the capstan head itself.

Right: Cable reels designed for handling sonar bodies with twin drums. Each drum has a clutch, brake and pawl mechanism. A sensitive control is fitted which gives an infinitely variable speed range from creep to maximum on the high-torque hydraulic motor.





Left: These compact self-tensioned winches are the convenient and safe method of handling helicopters used on Leander Class frigates. They are disposed triangularly; the control console can be sited in the hangar or elsewhere.

The winches are powered by MacTaggart Scott high-torque motors housed within the rope drums. The drive is gearless.

MACTAGGART, SCOTT & COMPANY LIMITED

Station Ironworks, Loanhead, Midlothian, Scotland

Telephone: Loanhead 311 Cables: Valve Loanhead Telex: 72478

SubIRS (Submarine-Installed Radiac System)

The submarine-installed Radiac system is similar in all respects to the system for surface vessels, except that the configuration is modified to suit submarine requirements.

Equipment

For the measurement of air dose rate a halogen-quenched Geiger monitor tube is used as the radiation detector. Its pulses are fed through a transistor blocking oscillator in the detector unit to provide a low output impedance and to avoid spurious pick-up in cables to the control cubicle. Here they are further amplified and fed to a logarithmic ratemeter.

The water activity measuring channel is electronically similar to the air dose rate channel. The unit is mounted inside the submarine and detects seawater activity through the hull.

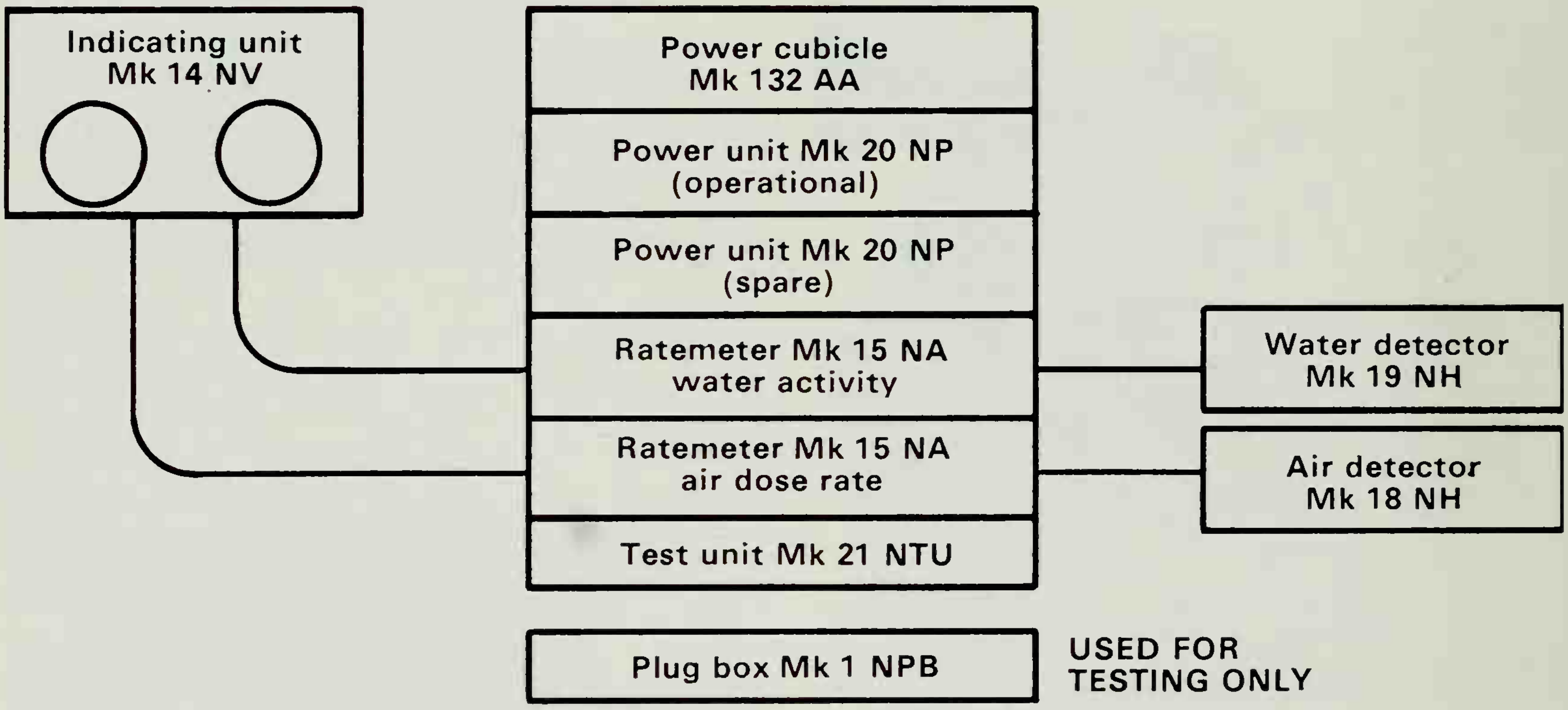
Continuous meter indication of air dose rate and water activity is provided on a 62 mm dia moving-coil meter with 100 mm long circular scales.

The magnetic visual alarm indicator shows 'high' when the preset levels are exceeded. Indication of power failure is also given.

A block diagram of a typical submarine installation is shown.

Dimensions

Unit	Description	Size (mm)	Weight (kg)
Mk 132 AA	Power cubicle	280 × 260 × 80	54
Mk 14 NV	Indicating unit	260 × 200 × 100	5
Mk 19 NH	Water activity detector	280 dia × 130	20
Mk 18 NH	Air detector	150 dia × 80	2
Mk 1 NPB	Plug box	280 × 280 × 200	9



Block diagram showing typical system for submarines

General features

The general arrangement and disposition of the various units making up a SubIRS system will vary for different types of submarine.

The air detector is intended for mounting in the snort or fin, as high as possible to avoid the need for complete surfacing when it is required to check for radio activity of the air from a submerged submarine.

The water detector of the SubIRS system measures radioactivity of the seawater through the hull of the submarine, whereas the water detector of the SIRS system for surface vessels is fitted in the condenser cooling water line. Water activity can therefore be measured in a submarine without the need to run any pumps, a feature which may be of vital importance when the submarine is being hunted by surface vessels.

The Mk 19 NH water activity detector of the SubIRS system is therefore larger and heavier than the Mk 26 NH water activity probe of the SIRS system, but bearing in mind the lack of space in submarines, the power cubicle and air activity detector of the submarine system are considerably more compact and lighter than those of the system for surface vessels. In the casing of the indicator units important savings in weight and space have also been achieved without sacrifice in readability and reliability.

Inter-connection between the various units forming the system is by standard cabling, so that any protection against radiation hazard which may be fitted within a vessel is not rendered less effective as a result of installing SIRS or SubIRS.

Audible alarms can be set to respond at any required level; the SubIRS alarm system can be muted.

Radiation alarm system

for ships and submarines

As long as there is a possibility of nuclear weapons being employed, it is essential for vessels of all types to have clear warning of radioactivity in air and water, since evidence of radioactive pollution is not always obvious at sea.The Automation Division of Plessey has developed an alarm system for this purpose available in two versions: the ship-installed Radiac system (SIRS) and the submarine-installed Radiac system (SubIRS).

SIRS (Ship-Installed Radiac System)

The ship-installed Radiac system provides early warning and an assessment of the hazards from:

a) direct gamma radiation from a nuclear weapon burst (including contribution to the total dose from the neutron 'flash' radiation),

b) gamma-emitting fallout on and around the ship,

c) fallout and induced radioactive contamination in the sea.

With this information effective NBCD counter-measures can be taken and the command is provided with a full appreciation of the radiological hazard.

The disposition of the detectors in the ship is such that the monitoring officer can obtain a continuous picture of the radiation levels throughout the ship, and hence be able to control evacuation and re-entry of compartments, produce a casualty forecast, and advise on the control of watch changing in the important manned positions.

Detectors of appropriate type are mounted above and below deck to monitor air activity and below deck to monitor water activity.

Indicators are normally mounted in the damage-control headquarters, on the bridge and in the operations room. The damage-control HQ indicator (Mk 1 NVA) displays continuously high and low-level air dose rates, and integrated air and water activity, gives visual indication of excess activity for both air and water and includes facilities for giving audible alarm if a preset level is exceeded.

The bridge indicator (Mk 3 NV) has red lamp indication and audible warning if the preset level is exceeded.

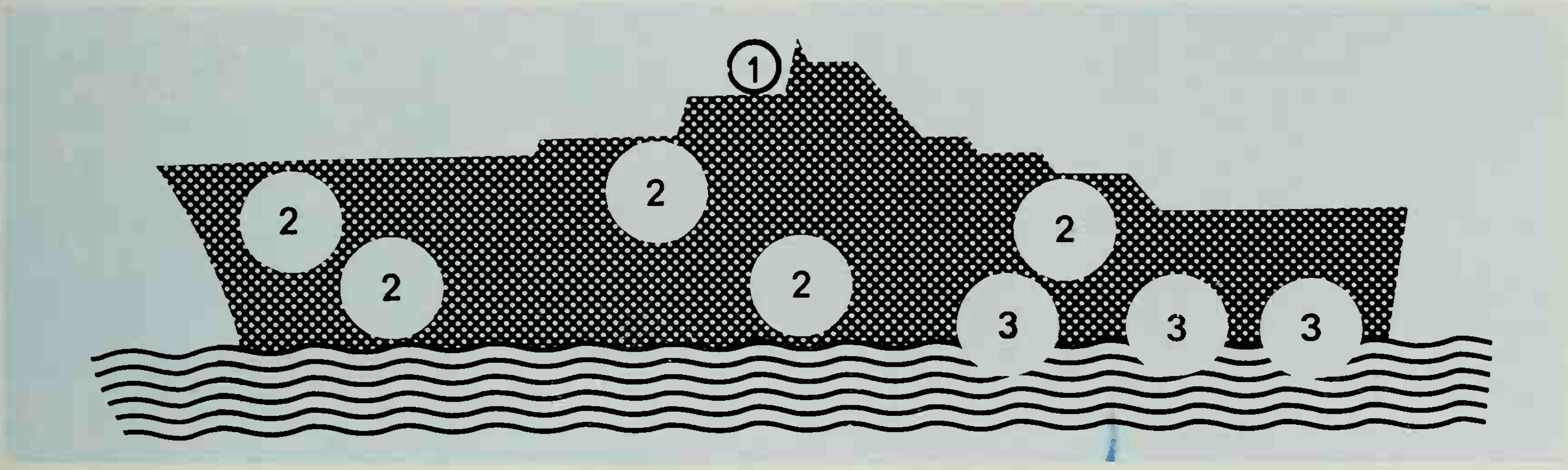
The operations room indicator (Mk 2 NV) repeats all the data being displayed at the central control position and has facilities for audible warnings.

Power for the system is provided from a power cubicle mounted in any suitable position.

Simulator

Provision is made by means of a plug box (Mk 5NX) to connect a portable simulator (Mk 2NG) into the system at the remote indicating unit (Mk 2NV) position, to simulate typical sequences of radiation effects corresponding to different types of weapons and conditions, to enable the ship's NBCD organisation to be exercised. The simulator is set up by using plug-in boards designed from records of both kiloton and megaton weapon trials. Manual controls are provided to vary the effects of washdown and deck shielding.

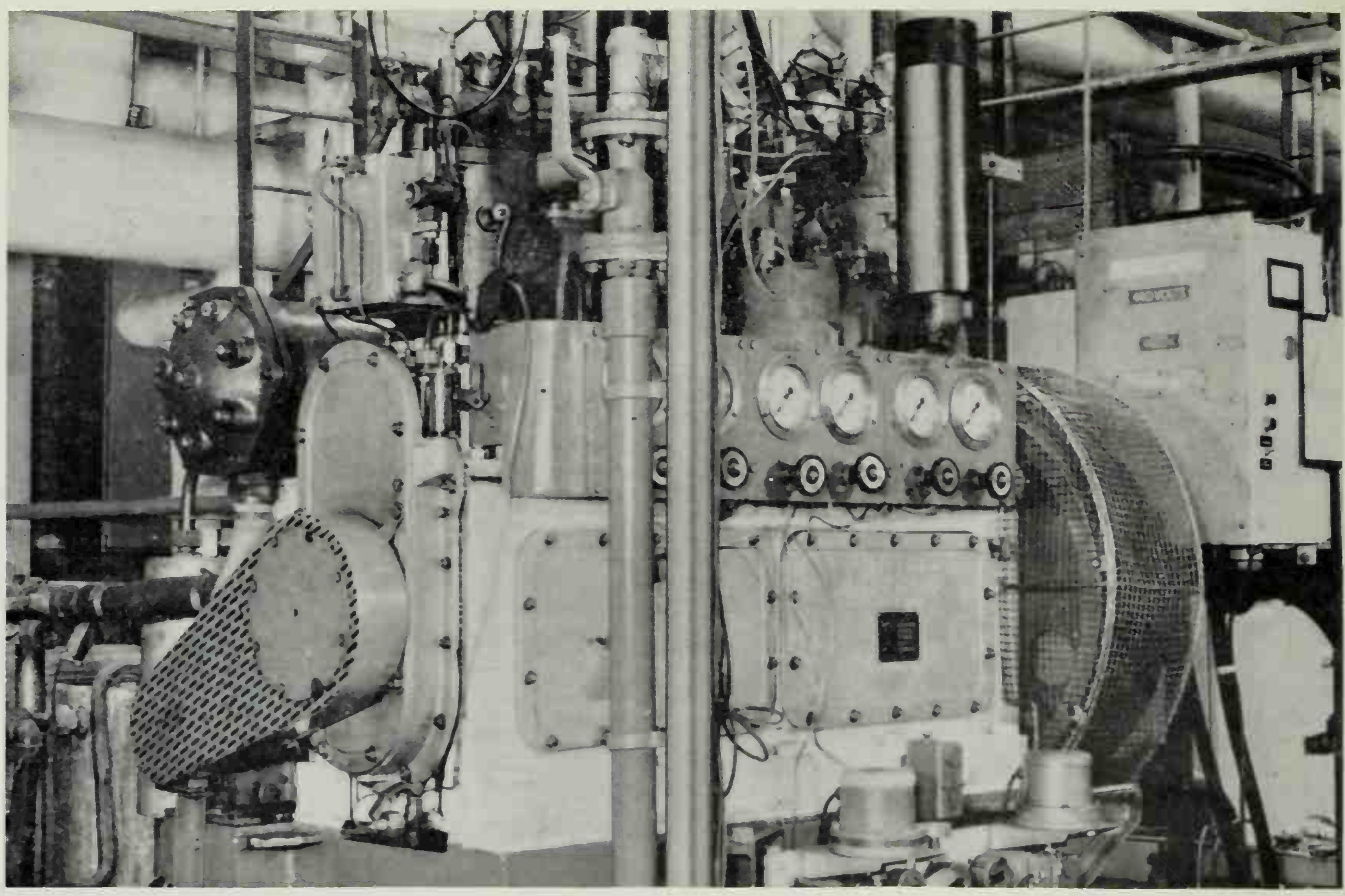
Unit	Description	Size (mm)	Weight (kg)
Mk 1 NVA	Indicating unit, damage control HQ	550 × 420 × 270	60
Mk 2 NV	Indicating unit, operations room	300 × 270 × 150	9
Mk 3 NV	Indicating unit, bridge	220 × 150 × 120	5
Mk 118 AA	Power cubicle	750 × 470 × 470	150
Mk 1 NHA	Detecting assembly, above deck	550 × 470 × 220	53
Mk 2 NHA	Detecting assembly, below deck	520 × 450 × 200	35
Mk 26 NH	Water activity probe	25·4 dia × 660	4



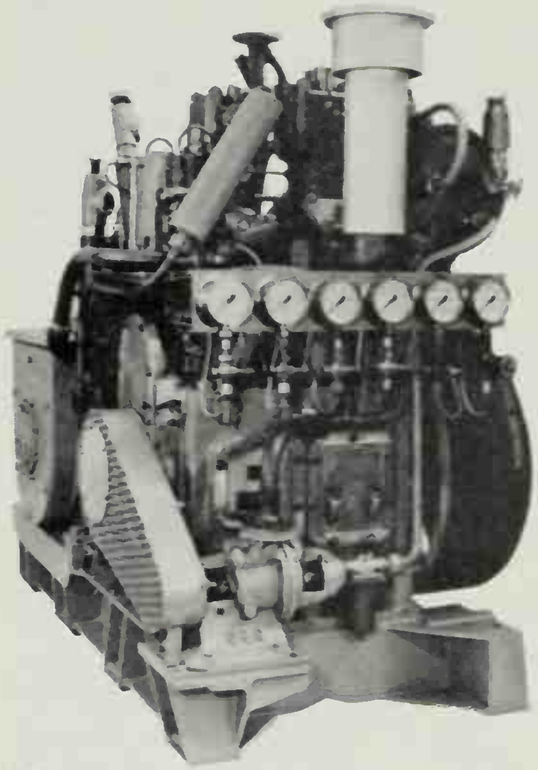
Typical arrangement of SIRS: (1) Above-deck detector Mk 1 NHA for high-level dose rate, low-level dose rate and total dose. (2) Below-deck detectors Mk 2 NHA for high-level dose rate and total dose. (3) Water activity detectors Mk 26 NH

THE PLESSEY COMPANY LIMITED
Automation and Transmission Divisions
Sopers Lane, Poole, Dorset, England
Telephone: Poole 5161 Telex: 41272

1969

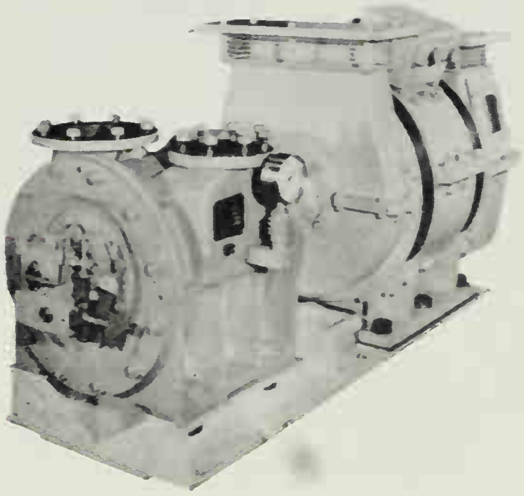


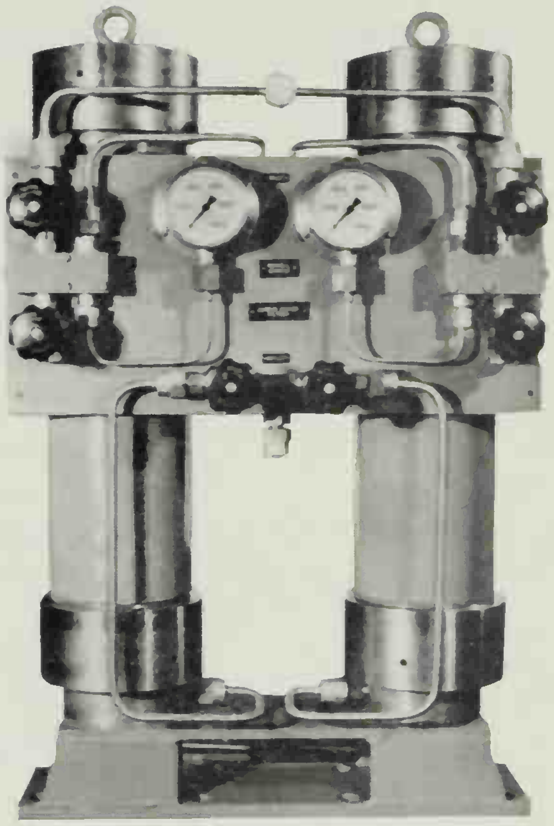
Balanced reciprocating high-pressure compressor



High-pressure air compressors (TC3½, TC4, TC6, TC8)

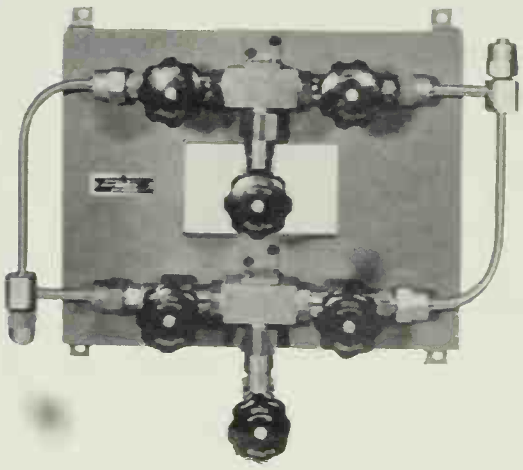
Submarine rotaries (XR12/13½)



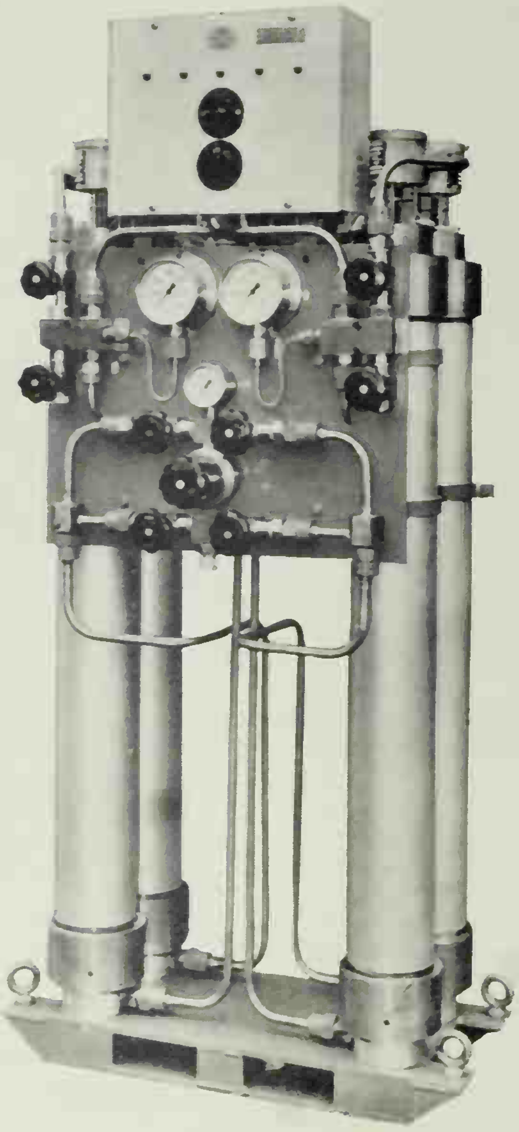


Hydrocarbon filter DHCF 100/6000

Solid particles filter DSPF 3/6000



Water vapour filter D2WVF 400/4000



Air compressors

for all classes of naval vessels

In modern operating conditions when the fleet relies on replenishing at sea, ships can remain on station for very long periods without returning to harbour. It follows that all machinery must be designed so that the utmost sustained reliability can be obtained with minimum of maintenance. Roll, pitch, vibration, corrosive conditions, high ambient temperatures and humidity are all normal hazards which must be accepted, but in warships machinery must also be able to withstand considerable accelerations due to shock caused by underwater explosions or surface action damage.

Reavell build compressors which meet the exacting specifications of Britain's Ministry of Defence and very nearly every ship in the Royal Navy is equipped with at least one Reavell compressor.

Compressors are supplied to provide high-pressure air in aircraft carriers and surface ships with modern weapons systems. Frequently pure air is required in these ships and Reavell also supply the air purification plants used in association with their high-pressure compressors. Other reciprocating type compressors are supplied to cruisers, destroyers, frigates, conventional submarines and assault ships all of which require air at high pressure for torpedo charging and many other important services including starting main propulsion and other gas turbine machinery. Special balanced compressors designed by Reavell are installed in nuclear submarines and other warships requiring vibrationless auxiliary machinery. Rotary compressors are supplied to most submarines for blowing ballast tanks on surfacing.

Balanced reciprocating high-pressure compressor

This four-stage, six-crank compressor is fully balanced and is specified for the latest nuclear submarines and for the new Type 42 destroyer for the Royal Navy.

High-pressure air compressors (TC3$\frac{1}{2}$, TC4, TC6, TC8)

These four-stage compressors are made in four sizes and have been supplied to the Royal Navy in very large numbers. They are in nearly every class of ship and are the standard compressor for pressures up to 280 kgf/cm^2 (4000 lbf/in^2). Capacities range from 70–210 m^3/h (40–120 ft^3/min). Modified TC4 and TC8 compressors are built to British MOD Standards and to the exacting requirements of United States Military Specifications.

Submarine rotaries (XR12/13$\frac{1}{2}$)

Rotary compressors built to deliver 1900 m^3/h (1100 ft^3/min) against 1 kgf/cm^2 (15 lbf/in^2) are supplied to submarines for blowing and trimming ballast tanks.

Air purification plant

There is an ever-increasing demand for purified compressed air, but the degree of purity required varies considerably according to the particular application.

Reavell specialises in high-pressure systems (140 atmospheres and above) and can provide equipment to cover every degree of purification required to suit any particular application. A Reavell air purification system is built up as a chain of separate components which can be supplied either as a whole to those who demand really pure air, or in part for those applications where a lesser degree of purity is acceptable.

Pure air is a term which has evolved recently to describe a defined standard of purity of air. This standard is judged by measuring the rate of air flow through an air liquefaction unit. If the flow rate is maintained within the defined limits over a period of time, the air is described as 'pure'. To achieve this standard, the air must have the moisture, oil vapour, carbon dioxide, solid particles and any other trace impurities reduced to a prescribed limit. Each contaminant is eliminated by a separate link in the chain, and each can be supplied to give a greater or a lesser degree of purity.

REAVELL AND COMPANY LTD
PO Box 44, Ranelagh Works, Ipswich, IP2 OAE, England
Telephone: Ipswich 56124 Cables: Reavell Ipswich Telex: 98254

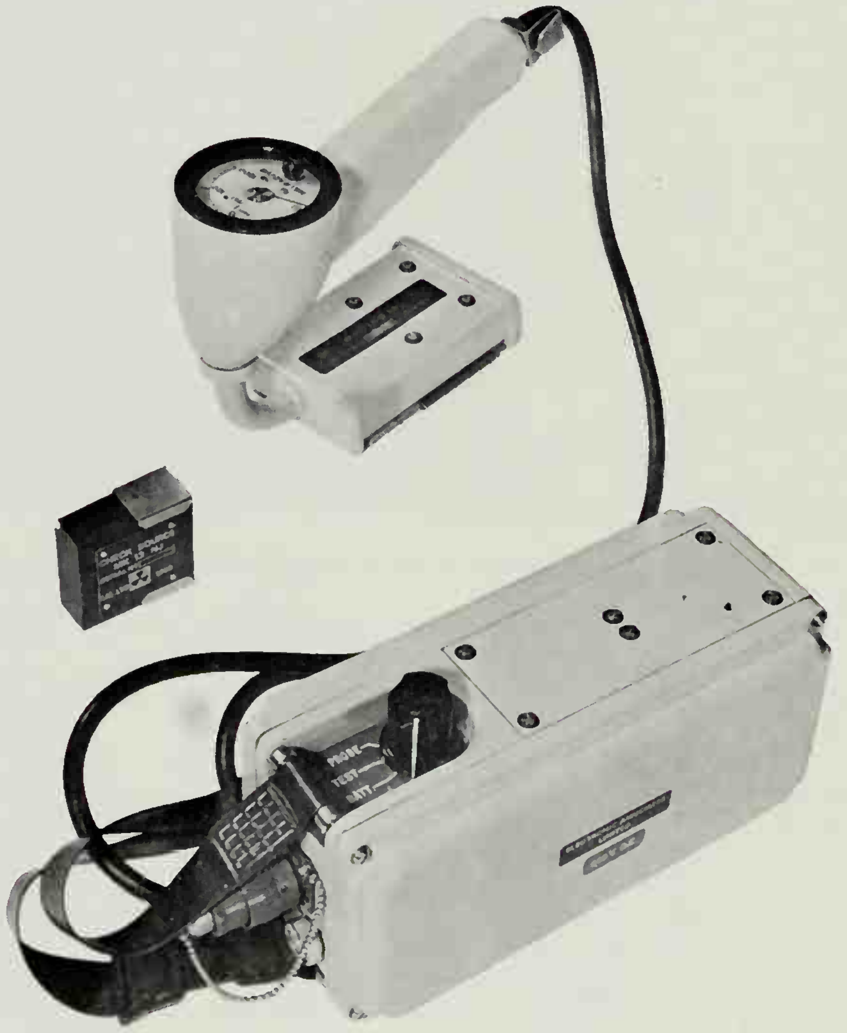
Reavell
A COMPAIR COMPANY

Radiation meter

Portable radiation measuring instrument

Developed for the British Ministry of Defence (Navy), the Radiac set MD2 is a compact portable instrument for the measurement of gamma radiation and the indication of beta radiation. A liquid contamination measurement accessory is also available.

In addition to the in-built meter indication, an output is provided to drive a headset or register unit. The Radiac set is supplied in a rugged transit case, which also houses a small radioactive check source.



Specification

Power source: three 1·5 V dry cells, NATO Stock Number 6135-99-910-1101
Operating temperature range: –10° C to +55° C
Type of indication: 240° circular scale meter with Betalight illumination
Range of indication: 0·1 millirad/h to 1 rad/h
Accuracy: generally ±20%
Detector: four Geiger-Müller tubes in parallel
Energy response: ±20% over the gamma range 80 keV to 3 MeV
Check source: radioactive test sample NATO Stock Number 6665-99-521-1887, supplied with each equipment to provide functional check facilities
Shock and vibration tests: the instrument is rigorously checked, including the following vibration search tests:

0– 15 Hz at ±2·4 mm (±0·06 in)
10– 30 Hz at ±0·8 mm (±0·02 in)
30– 80 Hz at ±0·4 mm (±0·01 in)
80–150 Hz at ±0·2 mm (±0·005 in)

Drop test: the instrument is dropped from a height of 15 cm (6 in) on each corner
Bump test: 4000 bumps with 2·5 cm (1 in) pre-fall
Packaging: NATO-approved transit case NATO Stock Number 6665-99-521-1888
Dimensions of packing case: 254 × 445 × 265 mm (10 × 17½ × 10½ in)
Weight, complete with case: 9·1 kg (20 lb)

ELECTRONIC ASSOCIATES LIMITED
Victoria Road, Burgess Hill, Sussex, England
Telephone: Burgess Hill 5101 Cables: Pace Burgess Hill Telex: 87183

Rubber components and products for naval equipment

Specialists in the design and development of rubber products for naval equipment. Avon produces moulded components and rubber-to-metal bondings for all naval requirements.

Avon develops and manufactures mounting systems for vibration insulation and isolation in machines and other equipment on naval and commercial sea-going vessels and shore installations.

Avon also makes rubber fenders and inflatable boats for special applications. Other products made are dry-diving dresses and Admiralty pattern full-face diving masks.

Avon specialises in the manufacture of rubber components for semi-closed-circuit re-breathing sets.

Avon Rubber Co Ltd
Bradford-on-Avon, Wiltshire, England

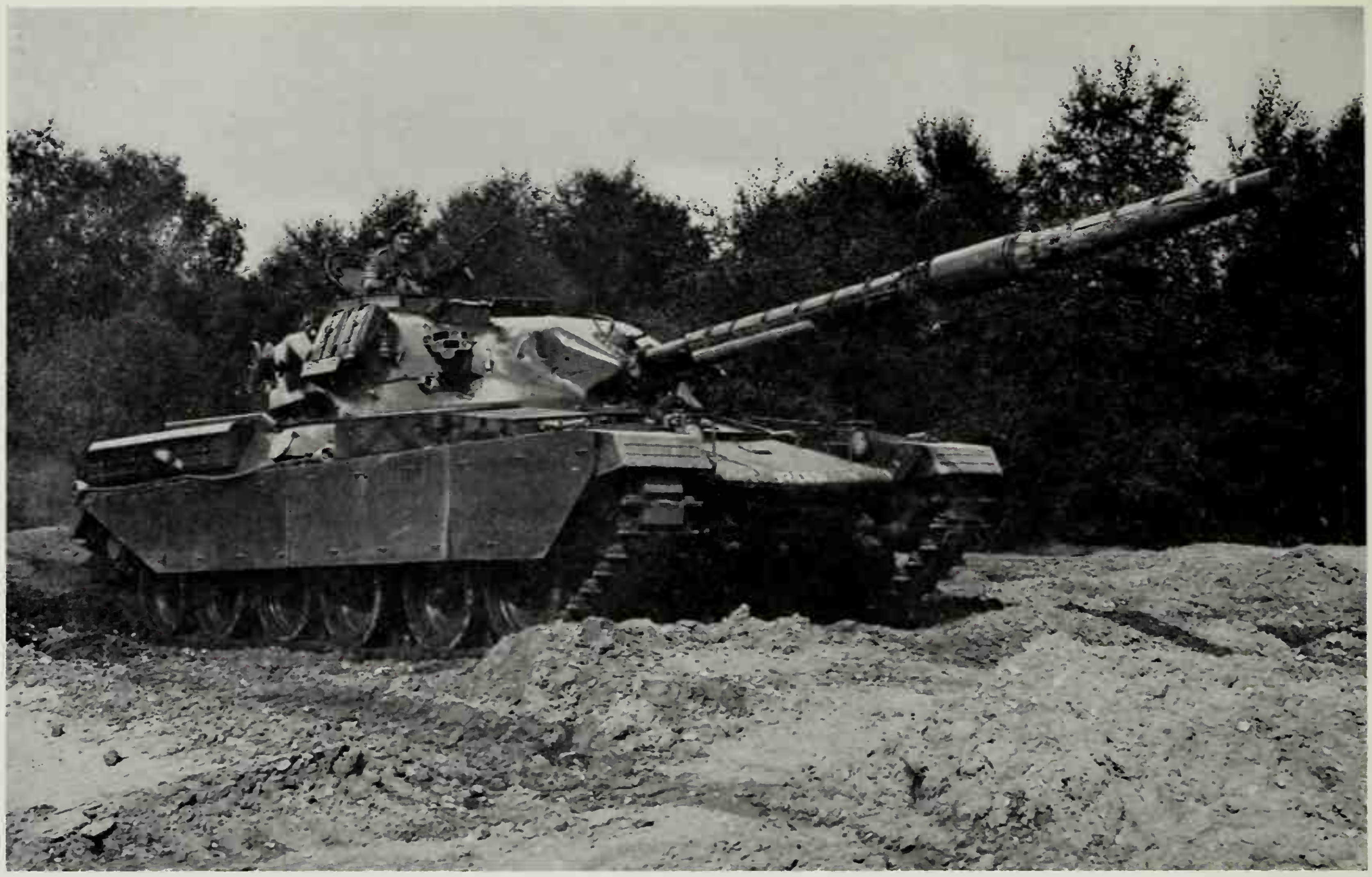
Telephone: Bradford-on-Avon 2191

Cables: Industrial Bradford-on-Avon

Telex: 44856

Section 7

Tanks



The Chieftain tank

The layout of the tank is conventional, with a forward compartment for the driver, a central fighting compartment for the commander, gunner and loader, and a rear compartment for the engine and gearbox.

The best possible protection has been provided. This has been achieved by reducing the internal volume of the vehicle and utilising the weight thus saved to thicken the armour over the frontal arc which is most likely to be exposed to enemy fire. Despite this reduction each crew member has enough space in which to work efficiently.

The turret has been made both lighter and less vulnerable by dispensing with the gun mantlet.

The 120mm bagged charge gun is mounted centrally in the turret and stabilised in both azimuth and elevation. Adequate ammunition for the normal day's engagement is carried, the charges being contained in specially developed fireproof containers.

A 12·7mm (0·50in) machine gun is mounted parallel with the 120mm gun and is used as a rangefinder. A 7·62mm machine gun is also mounted parallel with the main armament for use against infantry and 'soft' targets.

The commander's station incorporates a 7·62mm machine gun, all-round vision, a sight which allows accurate indication of targets to the gunner, and a lifting hatch giving direct vision with overhead protection.

Both the main and auxiliary engines are of the multi-fuel compression ignition type specially developed for this vehicle. An increased radius of action much in excess of that obtained with spark-ignition engines is achieved.

Salient features

Since the introduction of the Centurion tank at the end of World War II, much research and development has been directed to providing a tank with greater fire power, better protection and a larger radius of action, while at the same time embodying new requirements arising from lessons learnt in World War II as regards mobility, fire control, ammunition protection and stowage, and rate of fire. When compared with other tanks of its own class, the fighting capability of Chieftain, as expressed in the term 'gun/armour combination', is outstanding.

Chieftain embodies all the improvements for which the experienced tank soldier has asked. These have been achieved with a battle weight of 53 000kg (116 750lb). It thus surpasses the strategic and tactical mobility attained by the latest model Centurion.

Special features include:

1 A 120mm gun of extreme accuracy and outstanding ballistic performance using ammunition with separate bagged charges

2 Very short time to target engagement and the ability to hit the target with the first round of that engagement on most occasions. A simple and robust system of range determination is incorporated, using a ranging machine gun

3 A high degree of immunity against any likely enemy attack

4 A high degree of immunity to ammunition fires, by the use of special bins for stowing bagged charges

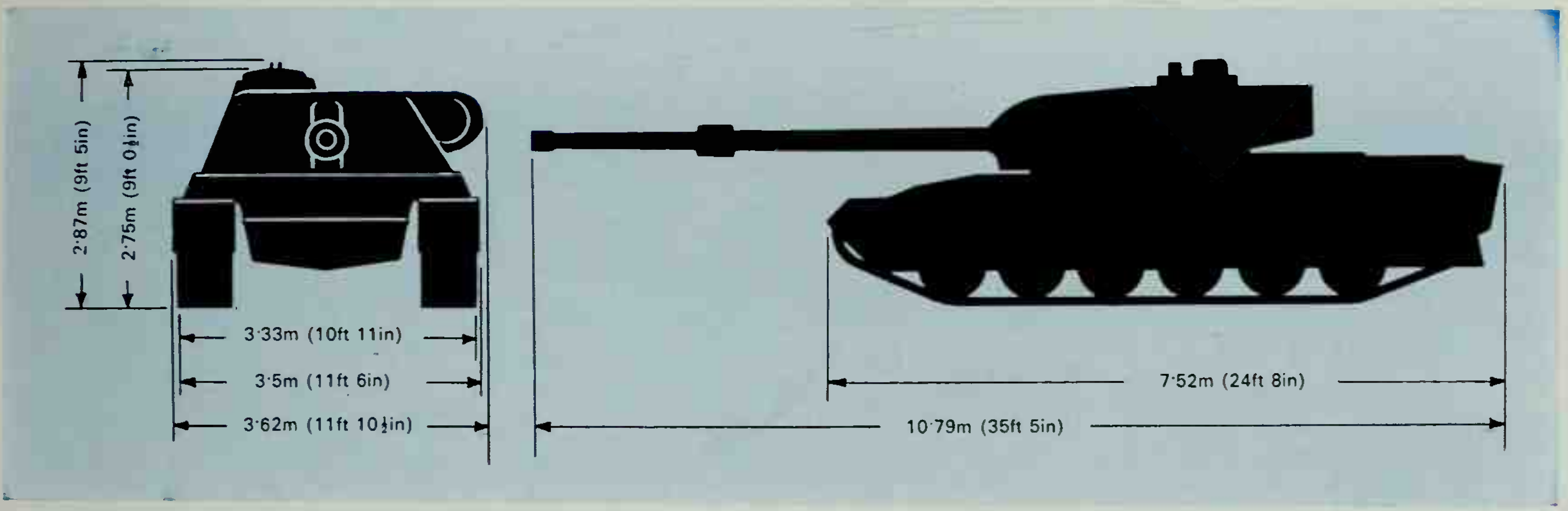
5 A multi-fuel engine which, because of its economical performance, gives a large radius of action

6 A reduced time for driver training and a reduction in driver fatigue. This has been achieved by providing an electrically operated gear shift and a centrifugal clutch

7 A built-in ability to accept snorkel deep-wading equipment

Chieftain

battle tank



General specification

Weight laden: 53 000kg (116 750lb) with rubber-padded track; unladen 50 347kg (111 890lb) with rubber-padded track

Dimensions
Length: gun forward 10·79m (35ft 5in); gun rear 9·75m (32ft)
Height: top of cupola 2·87m (9ft 5in)
Width: overall including searchlight 3·62m (11ft 10½in); over skirting plate 3·5m (11ft 6in); over tracks 3·33m (10ft 11in)
Tracks: approach angle 34 deg; departure angle 31 deg
Nominal ground pressure: 0·906kg/cm² (12·9lb/in²)
Turret ring diameter: 2·15m (7ft 1in)

Automotive performance
Road speed: up to approx 48km/h (30mph)
Cross country speed: considerably in excess of that achieved by the Centurion tank
Vertical obstacle: 0·9m (2ft 11·5in)
Maximum gradient: 35 deg (at full tractive effort)
Trench crossing: 3·1m (10ft 4in)
Shallow fording: 1·07m (3ft 6in)
Deep wading capability: 4·57m (15ft)
Range of action, on road at maximum speed: 402·25km (250m) on diesel fuel
Power-weight ratio 13·5bhp/ton (long) gross

Sighting and vision
*Binocular periscope AFV No 8 Mk 1
Commander's cupola: 1 sight periscopic AFV No 37 Mk 1 or Mk 2; 9 periscopes AFV No 34 Mk 1 or AFV No 40 Mk 1; 1 collimator AFV No 7 Mk 1
Gunner: 1 *sight periscope, AFV No 38 Mk 2; 1 sight unit, AFV No 26 Mk 1 (telescopic); 1 quadrant fire control AFV No 11 Mk 1
Loader: 1 periscope, AFV No 30
Driver: 1 *periscope, AFV No 36 Mk 1
*These periscopes can be replaced by infra-red equipment for night or poor light operation

Gun control system (Type FV/GEC No 7 Mk 4)
Manual and electric at the gunner's position and electric at the commander's position
Turret stabilised in azimuth and gun mounting in elevation, to provide stabilised power lay for gunner and commander with vehicle on the move
Commander's over-ride on power controls only
Provision for automatic line-up turret and commander's cupola
Emergency power traverse provided direct from vehicle batteries

Transmission
Gearbox: TN 12 Merritt-Wilson
Clutch: centrifugal
Steering: Merritt regenerative
Steering brakes: disc hydraulically actuated
Main brakes: disc for foot brake; band for parking brake
Final drive: single spur reduction
Final drive ratio: 5:1

Controls
Gear change: electro-hydraulic
Hand brake: mechanical
Foot brake: hydraulic—power-assisted
Steering: hydraulic, with mechanical interlock
Accelerator: mechanical

Suspension
Springs: helical—horizontal
Wheel deflection: bump 139·7mm (5·5in) (one wheel ring); rebound 89·9mm (3·25in)
Road wheels: 12 pairs of twin wheels in 6 bogies 127mm (5in) × 803mm (31·6in) dia
Tracks: dry pin, rubber-padded 609·6mm (24in) wide
Weight of tracks: 4363kg (9640lb) per vehicle set
Links per track: 94
Track pitch: 152·5mm (6·25in)
Sprocket: 12 teeth, twin ring 609·6mm (24in) outside dia

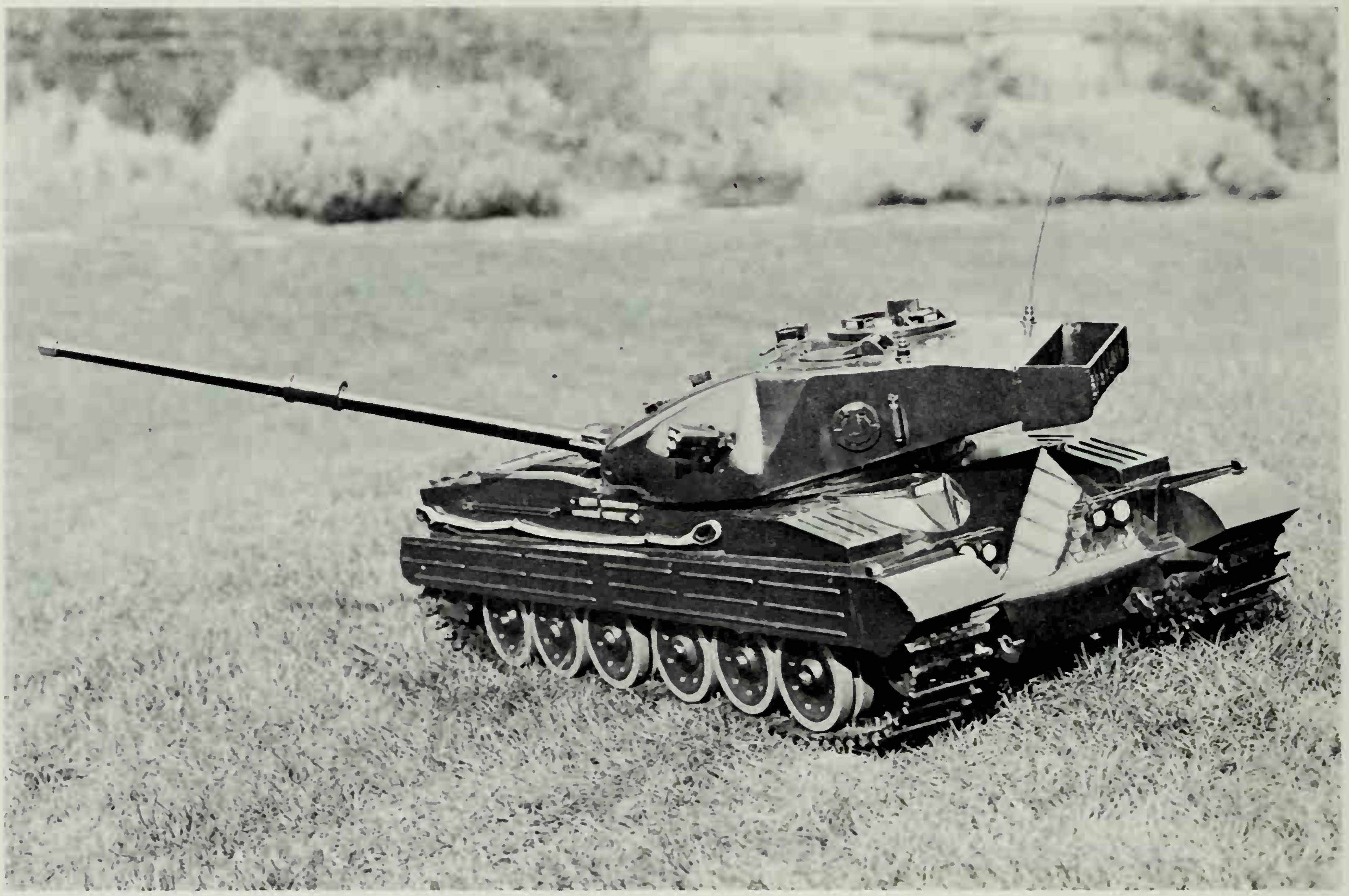
Communications
Radio equipment: radio sets C42 and B47 complete with A-type harness
Intercommunication: for all the crew
Remote control: 180m (200yd) cable reel No 1
Infantry telephone: on rear of hull
The basic vehicle is equipped to accept field conversion kits to both Command and Control roles
Separate 100Ah 24V battery is provided in turret (charged from the vehicle system) providing 8h silent watch for basic radio installation

Electric system
28·5V (24V nominal) dc
Two dc generators, 150A continuously rated output above 1000rev/min on main engine, 350A continuously rated output on auxiliary engine, with parallel operation of both
Single-phase 267Hz 200V 1·5kVA 0·98 pf output provided on auxiliary engine generator in addition to dc output for battery heating. 200Ah batteries provided in hull for engine starting and general electrical services. In addition 100Ah batteries provided in turret for radio loads and emergency power supply to fighting equipment
All hull wiring is double-pole insulated return to prevent radio interference due to currents through the turret race
Generator No 5 Mk 4 on main engine
Generator/alternator No 1 Mk 2 on auxiliary engine
Batteries: 4 × 12V UK/6TN No 4 Mk 2 in series/parallel in hull; 2 × 12V UK/6TN No 4 Mk 2 in series in turret

Night fighting equipment
Unarmoured dual-purpose searchlight in conjunction with infra-red sighting equipment
Searchlight power consumption approximately 100A at 28·5V
Infra-red driver's sight and twin 100W driving lights
Commander's infra-red light source in conjunction with infra-red sighting equipment or common user binoculars

Fire fighting equipment
Detection and warning system
Graviner Mk 2 firewire routed throughout engine compartment

MINISTRY OF DEFENCE
Director of Sales (Army)
St Christopher House, Southwark Street, London SE1, England
Telephone: 01-928 7999



Vickers Elswick Works at Newcastle upon Tyne have been manufacturing and producing fighting vehicles continuously for 50 years and have been the design parents for most of the tanks used by the British Army, including Centurion and Chieftain. This long experience has culminated in the design of the present series of Vickers fighting vehicles, including that of the Vickers main battle tank shown above

Specification

Crew: 4 men

Dimensions
Laden weight: 38·6 t (38 ton)
Overall length (gun forward): 9·79 m (32 ft 1 ⅜ in)
Overall height (to turret roof): 2·49 m (8 ft 2 in)
Overall width: 3·17 m (10 ft 4 ¾ in)

Armament
Gun: QF 105 mm high-velocity gun
  Elevation: 20°
  Depression: 10°
Rate of fire: 10 rounds per minute
Ranging device: 12·7 mm (0·5 in) machine gun, mounted parallel to main gun
Ammunition stowage: 50 rounds
Machine gun: 7·62 mm (0·30 in) mounted parallel to main gun

Optional equipment
Commander's machine gun: 7·62 mm (0·30 in) pintle-mounted

Engine: Leyland L.60, 676 bhp SAE
Speed, max: 53·2 km/h (33·25 mph)
Operating range (approx): 480 km (300 road miles)

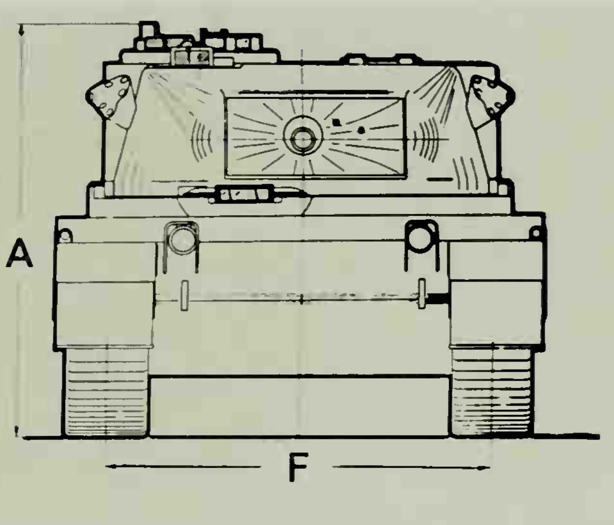
Amphibious capability
Wading depth (without preparation): 1·14 m (3 ft 9 in)
Water crossing (optional equipment): swimming with built-in nylon screen using track propulsion

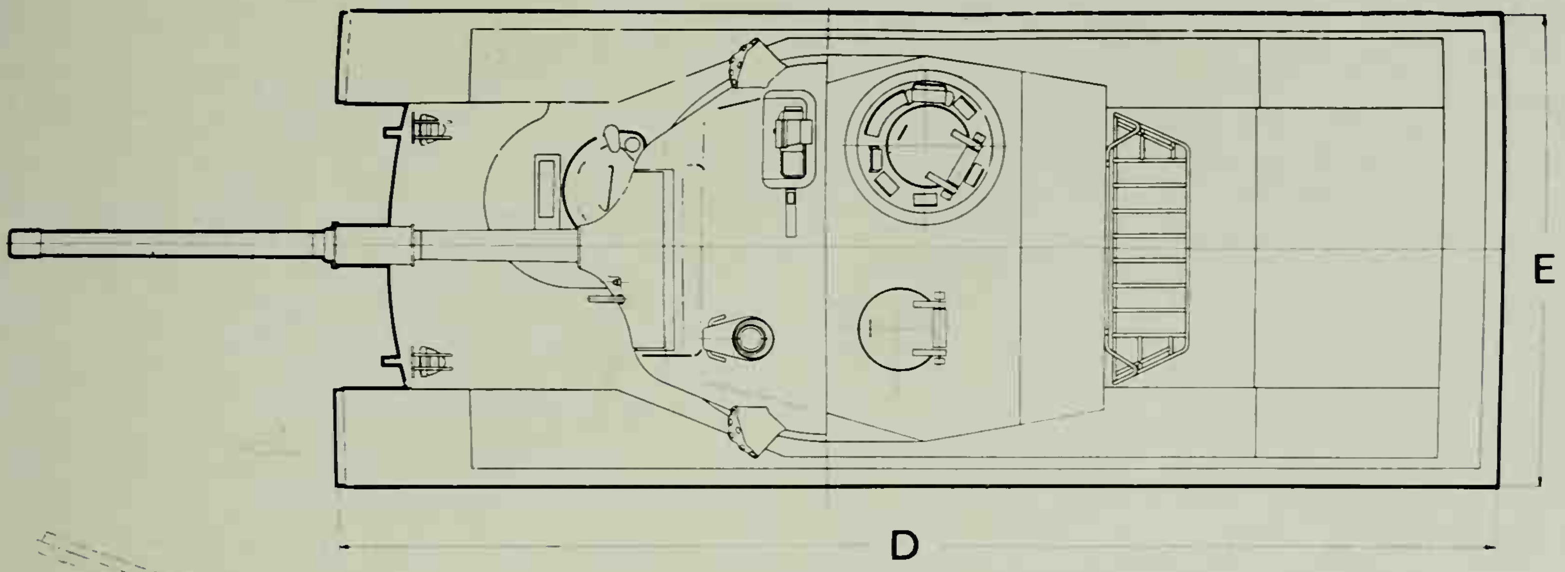
Battle tank

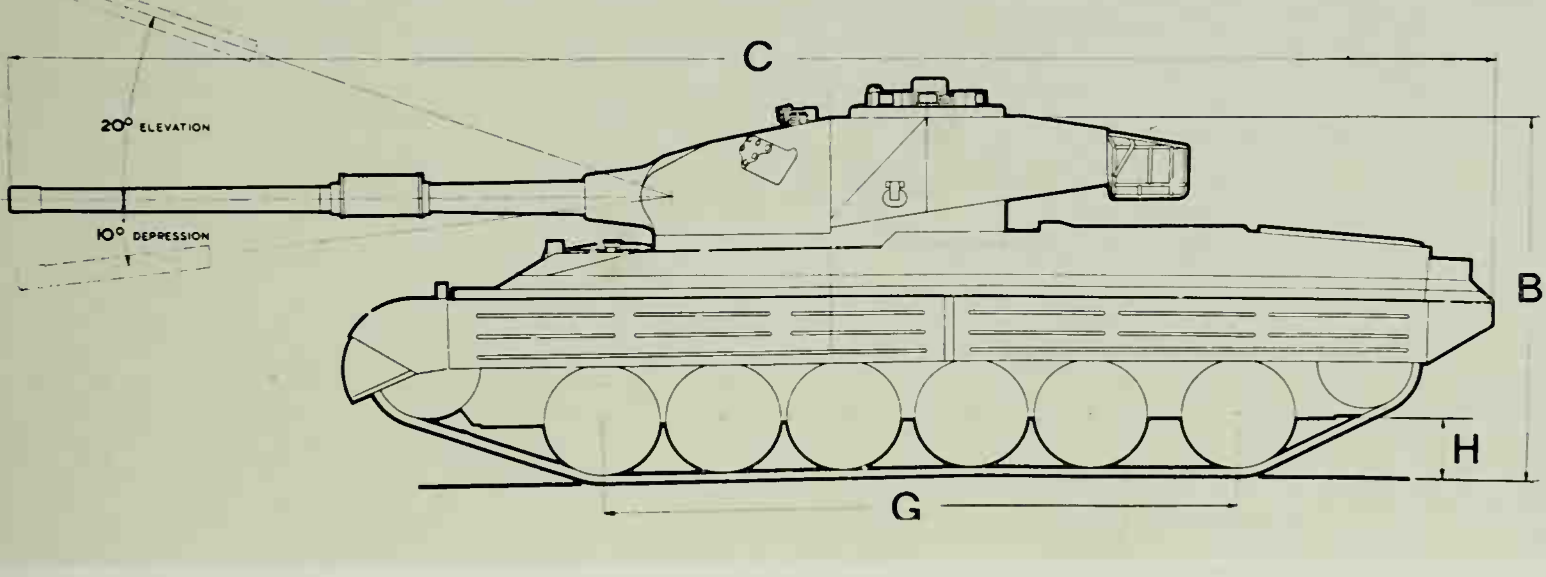
Vickers main battle tank Mk 3

The Vickers battle tank is designed in accordance with the philosophy that firepower has first priority with mobility and armour protection following in that order. The weapon system comprises a high-velocity 105 mm gun, ballistic graticule sight with ranging machine gun, all fully stabilised with the latest transistorised equipment having greatly improved performance coupled with simpler maintenance. Secondary armament takes the form of a machine gun mounted parallel with the 105 mm gun and a commander's machine gun. The automotive components comprise a multi-fuel engine and six-speed semi-automatic transmission. Armour protection is the maximum available within an overall weight of 38·6 metric tons. Water-crossing capability is provided for by a built-in nylon swimming screen.

A—Overall height: 2710 mm (8 ft $10\frac{3}{4}$ in)
B—Height to turret roof: 2490 mm (8 ft 2 in)
C—Overall length, with gun: 9788 mm (32 ft $1\frac{3}{8}$ in)
D—Length without gun: 7560 mm (24 ft 9 $\frac{11}{16}$ in)
E—Overall width: 3168 mm (10 ft $4\frac{3}{4}$ in)
F—Track centres: 2533 mm (8 ft $3\frac{3}{4}$ in)
G—Centres, front to rear sprung wheel: 4280 mm (14 ft $0\frac{1}{2}$ in)
H—Ground clearance: 406 mm (1 ft 4 in)







VICKERS LIMITED
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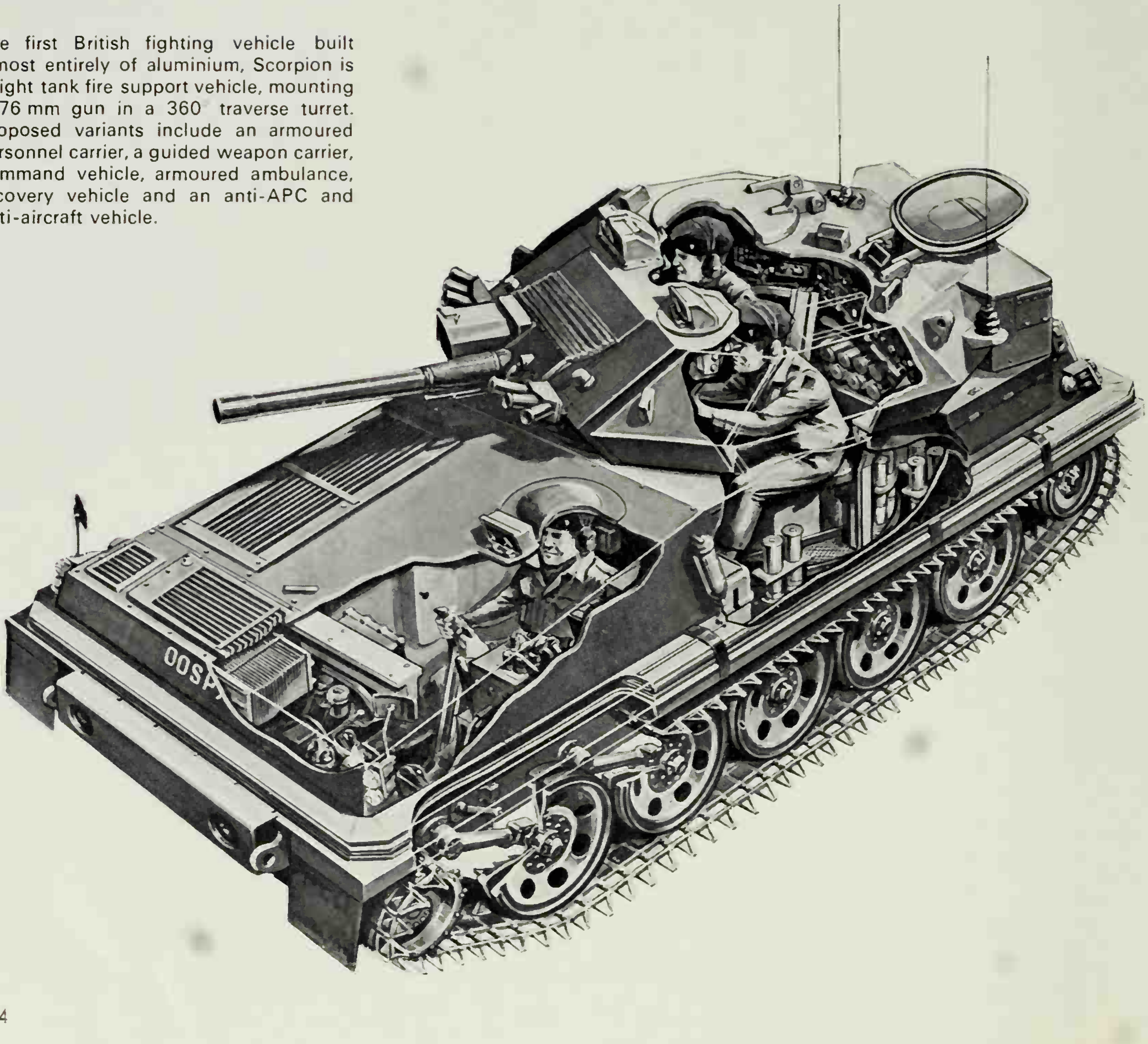
Section 8

Armoured vehicles

The first British fighting vehicle built almost entirely of aluminium, Scorpion is a light tank fire support vehicle, mounting a 76 mm gun in a 360° traverse turret. Proposed variants include an armoured personnel carrier, a guided weapon carrier, command vehicle, armoured ambulance, recovery vehicle and an anti-APC and anti-aircraft vehicle.



Scorpion

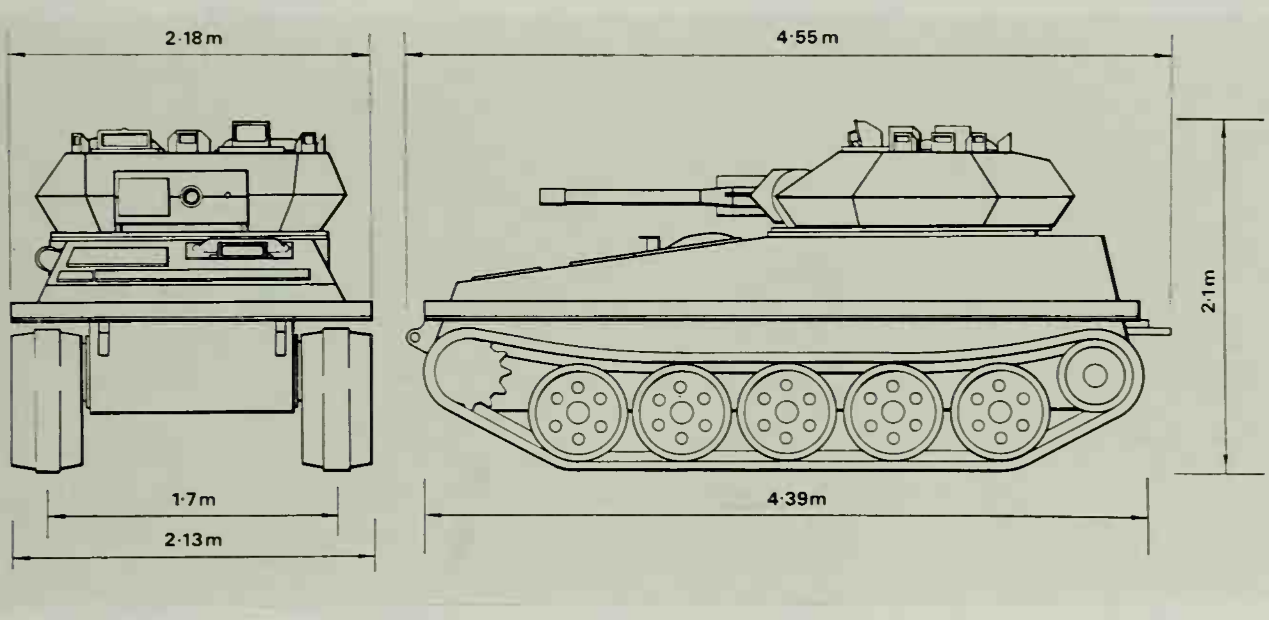
light tank

The Ministry of Defence and Alvis Limited of Coventry jointly introduce the new family of lightweight tracked armoured fighting vehicles. The first of these is the Scorpion, developed to a British Army specification for use in conditions demanding high power/weight ratio, low ground pressure and positive traction over bog, swamp and snow.

The first British fighting vehicle built almost entirely of aluminium, Scorpion is a light tank fire support vehicle, mounting a 76 mm gun in a 360° traverse turret. Proposed variants include an armoured personnel carrier, a guided weapon carrier, command vehicle, armoured ambulance, recovery vehicle and an anti-APC and anti-aircraft vehicle. Scorpion has been designed to meet the military requirements of the 1970s and 1980s for a low-cost highly manoeuvrable armoured fighting vehicle, capable of operating by day or night in a variety of roles. It is proposed that it will be used by the British Army principally in the fighting reconnaissance role and as an air-portable fire support vehicle, capable of operating with combat units and formations in all parts of the world.

Scorpion, because of its specification and characteristics, will be an ideal vehicle for convoy escorts and internal security roles. Low maintenance and servicing requirements will enable it to operate over long distances and in remote areas. Simplicity of operation has been given high priority, greatly reducing operating fatigue and eliminating long and costly specialised training.

Quite apart from it initial costs, the Scorpion offers even more important savings in terms of both money and manpower. Because of the extreme versatility of the basic design, it will be possible to build up armoured fighting units for almost any tactical purpose—complete with all necessary command and support vehicles—with spares and servicing facilities common to all vehicles.



Specification

Dimensions
Maximum height: 2·1 m (82·7 in)
Maximum width: 2·13 m (83·8 in)
Maximum length: 4·55 m (179·1 in)
Track centres: 1·7 m (66·9 in)

Protection
Hull of special aluminium alloy to latest techniques and specifications. Heaviest armour over frontal arc. Hull sides, tracks, road wheels and suspension give good side protection. Turret and upper surfaces well sloped.

Armament
Gun: 76 mm, 360° traverse, +35° elevation, −10° depression
Machine gun: for ranging 7·62 mm, parallel with main gun
Smoke dischargers: two, on turret
Ammunition: 40 rounds of 76 mm HE, HESH, smoke cannister and illuminating 3000 rounds of 7·62 mm, 18 smoke discharge grenades

Sights
Commander: binocular, 10 × and 1 ×
Gunner: binocular, day/night, 8 × and 1 ×
Driver: wide-field periscope, passive night sight optional

Mobility
Max road speed: 80·5 km/h (50 mph)
Vertical obstacles: 50 cm (20 in)
Maximum gradient: 31° (60%)
Trench crossing: 2 m (81 in)
Approach angle: 26°
Departure angle: 21½°
Power/weight ratio: 26·3 bhp/ton at 7940 kg (17 500 lb)
Ground pressure: 352 kg/cm^2 (5 lb/in^2)
Fording without preparation: 107 cm (42 in)

Engine
Make: Jaguar XK petrol six-cylinder 4200 cm^3
Maximum hp (gross): 195 bhp at 5000 rev/min. (This is a militarised de-rated version of the unit which powers the Jaguar 420 motorcar)

Transmission
Gearbox: semi-automatic hot-shift with 7 speeds forward, 7 speeds reverse
Steering: Merritt system, incorporated in gearbox
Steering brakes: caliper discs, hydraulic operation
Main brakes: caliper discs, hydraulic operation

Suspension
Springs: transverse torsion bar
Road wheels: solid rubber tyres bonded to aluminium alloy wheels
Tracks: light steel, with rubber bushes and pads
Links per track: 79
Weight per track: approximately 318 kg (702 lb)

Electrical system
Supply: 24 V negative earth
Batteries: 2 × 2 in series, 100 Ah 12 V each
Generator: 90 A or 140 A
Radio equipment: to individual specification

ALVIS LIMITED
Holyhead Road, Coventry, CV5 8JH, England
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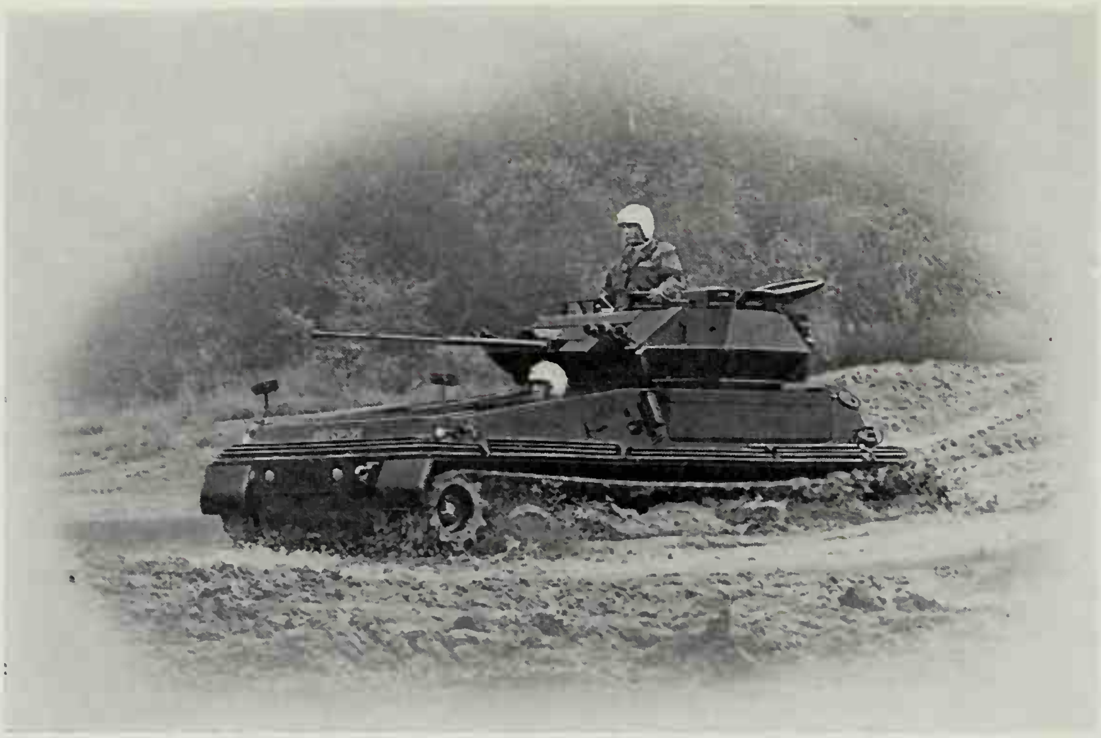
Additional vehicles to the Scorpion family are under development and brief details are given below and opposite. Further particulars are available from Alvis Ltd.



Scimitar

Rarden 30 mm cannon version

This vehicle uses the basic Scorpion hull and turret but has been modified to mount the Rarden 30 mm cannon instead of the 76 mm gun, and to carry 99 rounds of 30 mm ammunition. Scimitar is designed to meet a British requirement for worldwide reconnaissance and security roles, while retaining a good capability against light armour. Its overall weight is about 7500 kg (17 200 lb).

The Rarden cannon, fully described elsewhere in this Catalogue, is a tank gun with automated sliding breech designed specially to provide good anti-armour capability against existing and future enemy light armour and APCs. It can also defeat the sides and rear of heavier tanks. The HE round can deal with unarmoured targets behind light cover and deter low-flying aircraft and helicopters.

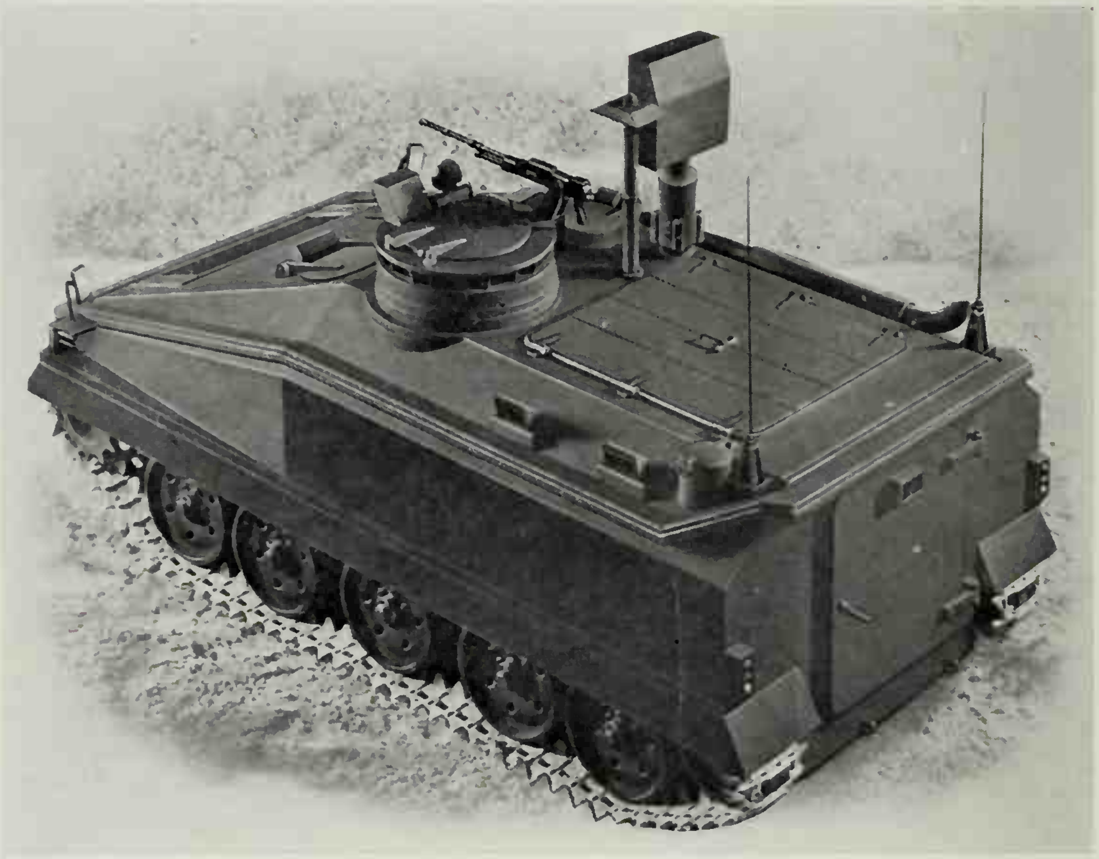
Spartan

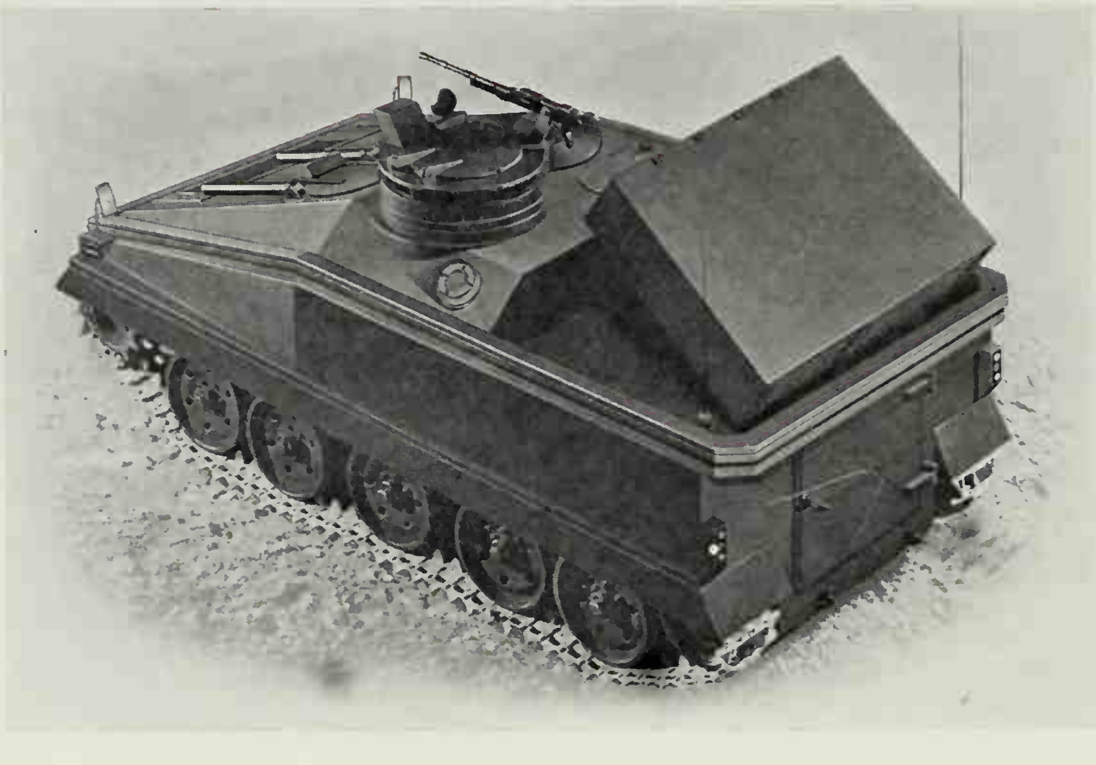
armoured personnel carrier

Spartan has been designed to accommodate the British assault section of seven men. The crew includes the driver, gunner, section commander and four men. Provision is made for stowage of weapons and full equipment plus a variety of other stores such as mines and explosives.

A 7·62 mm machine gun is mounted in a cupola permitting traverse and elevation, aiming, firing and re-loading from under armour. The sight is a periscope monocular, ×1/×10 magnification; additional episcopes give the section commander all-round vision. There is a built-in night sight. The commander's spotlight is linked to the machine-gun mounting. Further periscopes are provided in the sides and a vision block in the rear doors for the crew.

A ZB298 radar scanner is mounted on the roof, while the display unit and batteries are inside the vehicle. The complete radar installation can be used as a man-portable ground surveillance set.





Striker

anti-tank guided weapon vehicle

Striker is designed to provide long-range anti-tank capability. As with Spartan, the main components and layout are similar to Scorpion but with a slightly higher hull roof line.

The Swingfire missile system is as used on the current range of British guided weapon vehicles. Five missiles are carried in protected launchers on the rear of the hull. The launchers are elevated by an hydraulic ram for firing. They are re-loaded from outside the vehicle, from the five spare missiles carried under armour in the hull.

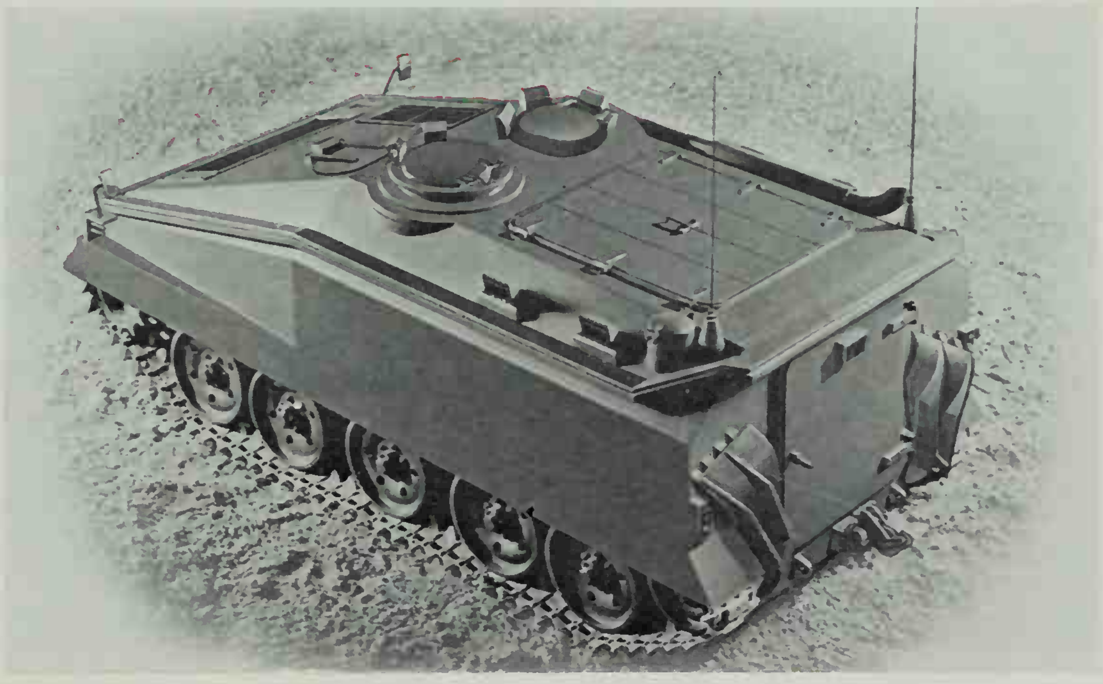
Scorpion variants

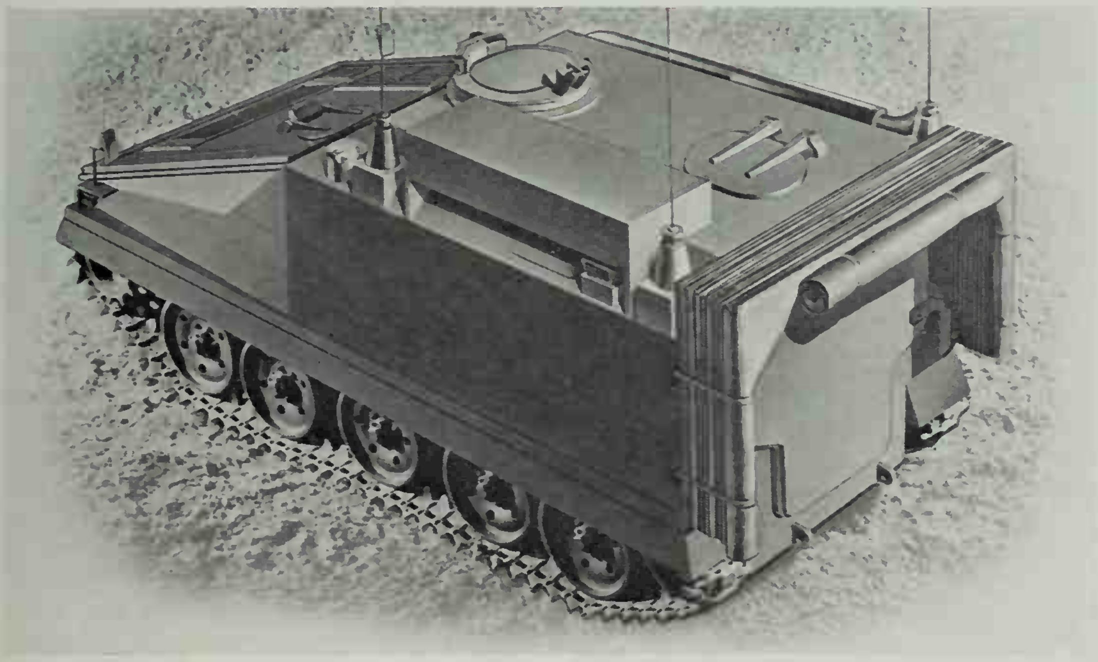
for diverse operational roles

Samson
armoured recovery vehicle

The recovery winch fitted inside the hull is driven from the main engine. It has a variable speed of up to 120 m/min (400 ft/min) on the 225 m (750 ft) of wire rope. Maximum pull, with a 4:1 snatch block, is 12 tons, enabling Samson to tow vehicles across a river or to aid at river crossings.

Trials are in progress of an applique propeller kit which will improve the water performance (giving a water speed of 5½ knots or nearly 9 km/h) and manoeuvrability. It is intended that this kit should be available for the whole tracked family.



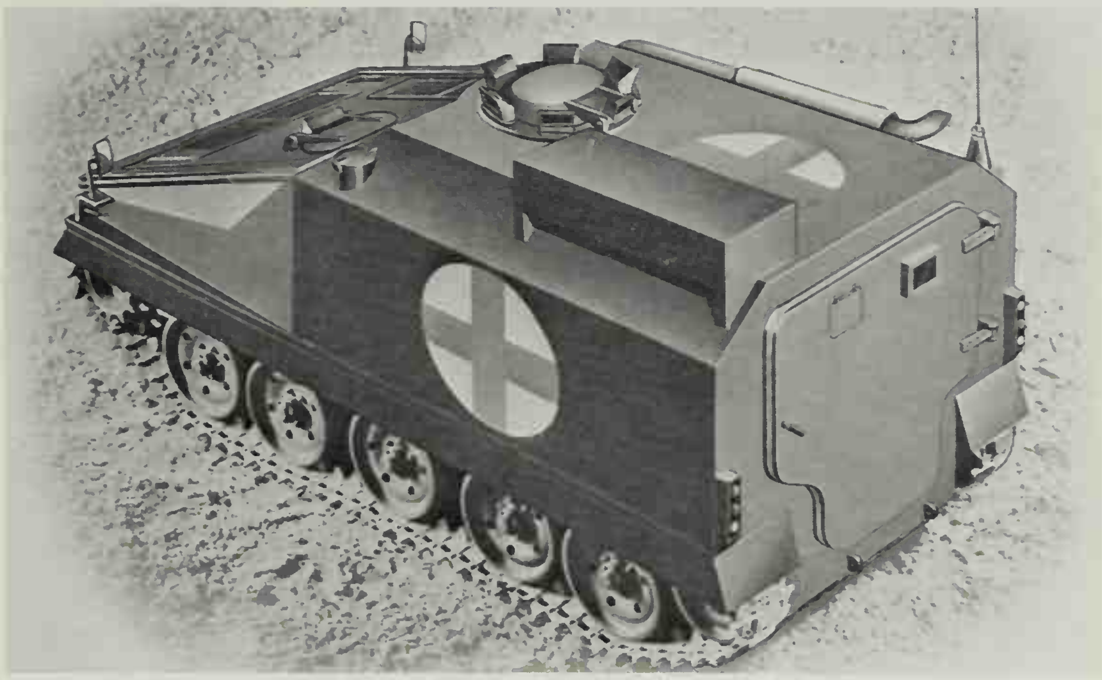


Sultan
armoured command vehicle

A special hull, giving 300 mm (12 in) greater headroom inside than the armoured personnel carrier version, allows greater stowage in the command vehicle. A spacious penthouse is mounted at the rear to give double the accommodation of the hull.

Samaritan
armoured ambulance

Using the same hull as Sultan, the Samaritan armoured ambulance has, in addition to the driver and medical orderly, accommodation for four stretcher cases and three sitting cases or six sitting cases.



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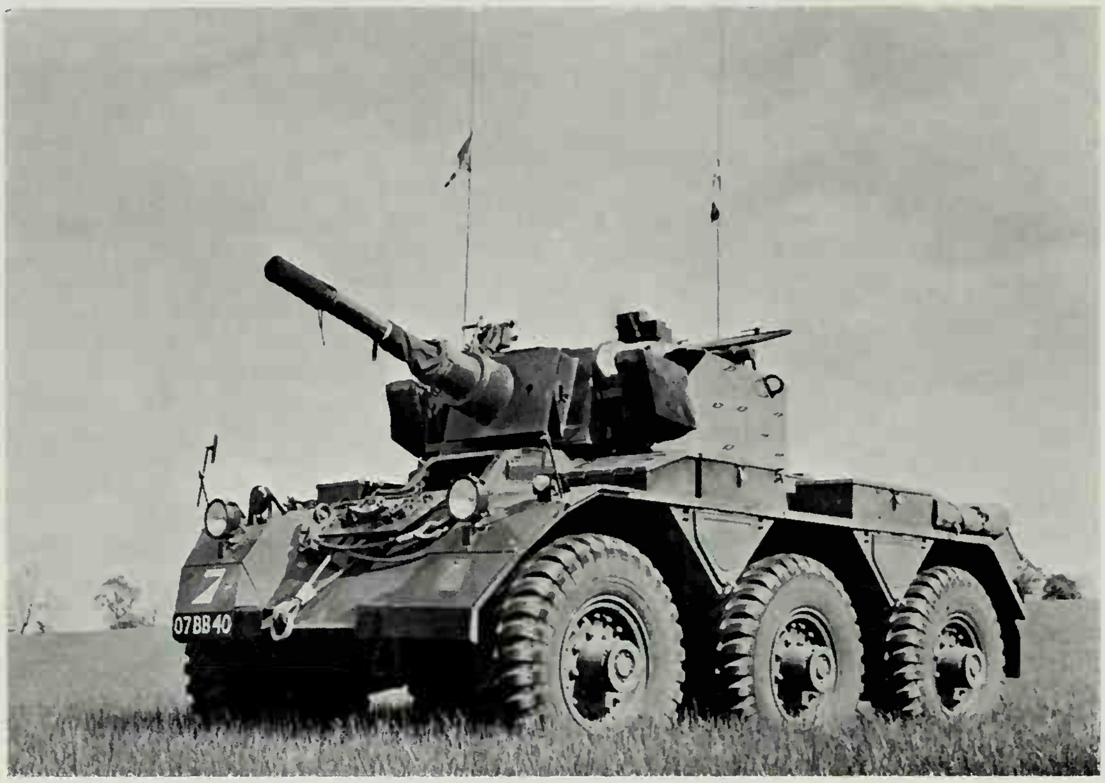
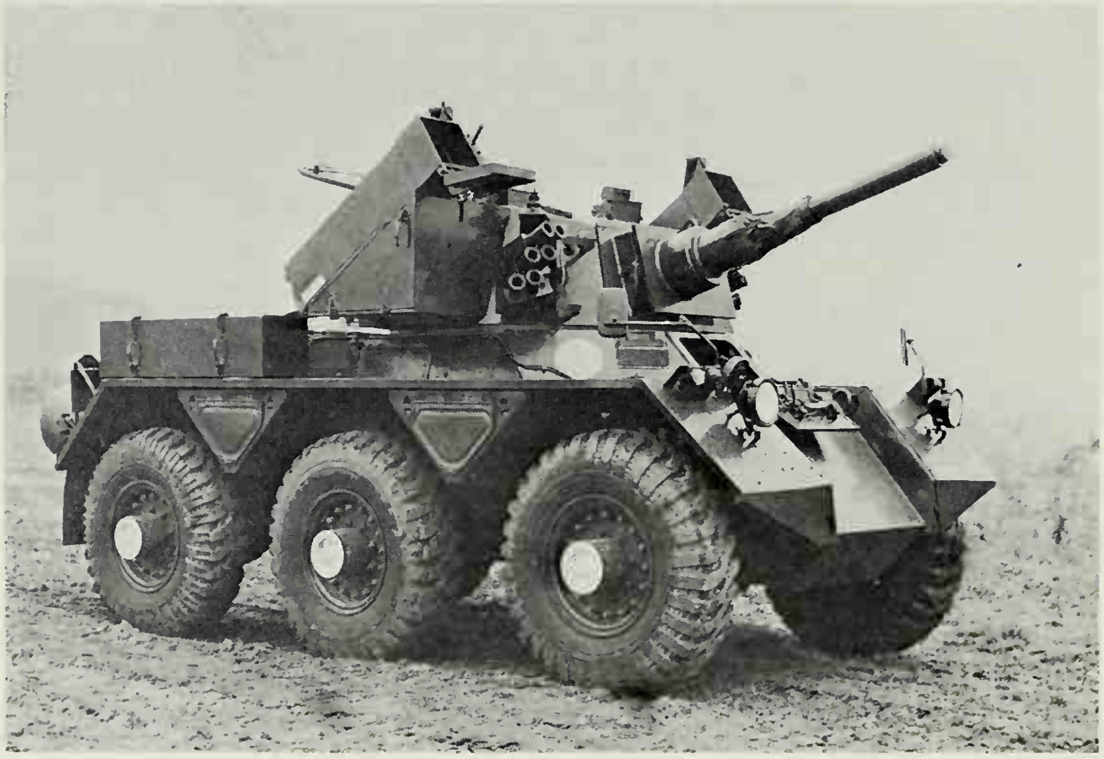




The mobility, performance and fire power of Saladin make it suitable for a great variety of military, security and police roles. As an armoured reconnaissance vehicle it is especially suitable for the advance contact function, for observation and surveillance, battle reporting and rapid forward reconnaissance. In internal security, Saladin's roles include mobile patrol work, anti-arms smuggling duties, roadblocks, escorts for convoys, VIPs, etc, and communications tasks of all kinds. Saladin is also suitable in the counter-insurgency role for close support of infantry and for fire support in situations where artillery is not available or unable to go into action in time.

Saladin's main armament, a powerful and accurate 76mm field gun, has an elevation of +20° to –10°, and a hand- and power-assisted traverse of 360°. It fires HESH, HE, Smoke and SH/PRAC fixed ammunition; 42 rounds can be stowed in the vehicle. An 0·30-in Browning machine gun is mounted parallel with the main armament. The commander's machine gun, another Browning 0·30-in weapon, gives ground and AA cover. Storage is provided for 2750 rounds. There are also 12 smoke dischargers mounted on the turret. The armour of Saladin gives adequate protection against mines, mortar and field artillery splinters, small arms ball and AP attack, nuclear blast, and heat flash.

In certain military roles the versatility of the Saladin has shown it to be an ideal vehicle for the carrying and launching of ground-to-ground missiles. Alvis, working closely with the British Aircraft Corporation, has developed an installation which enables Saladin to carry the BAC Swingfire missile, either as a retrospective modification of vehicles already in service, or for embodiment in production vehicles.

Saladin

armoured car

The Saladin is a six-wheeled, high-performance armoured car weighing 11 176kg (11 tons) and mounting one 76mm and two 0·30-in Browning machine guns. It is the standard armoured car of the British Army and has proved its capabilities in active service operations in many parts of the world with British, foreign and NATO Forces. A modern fighting vehicle that is being constantly developed to maintain its lead, it is destined for service until well into the 1980s. Overseas users are automatically consulted and kept up to date with improvements and modifications on equal priority with the British Army.

The Saladin is capable of operating under all conceivable climatic conditions, from arctic to tropical. With special fording kit it can negotiate water to 2·13m (7ft) deep, and it can be equipped to swim at 4km/h (2·5mph).

Main armament of the Saladin is an accurate 76mm field gun with 360° traverse, firing fixed ammunition of the following natures:

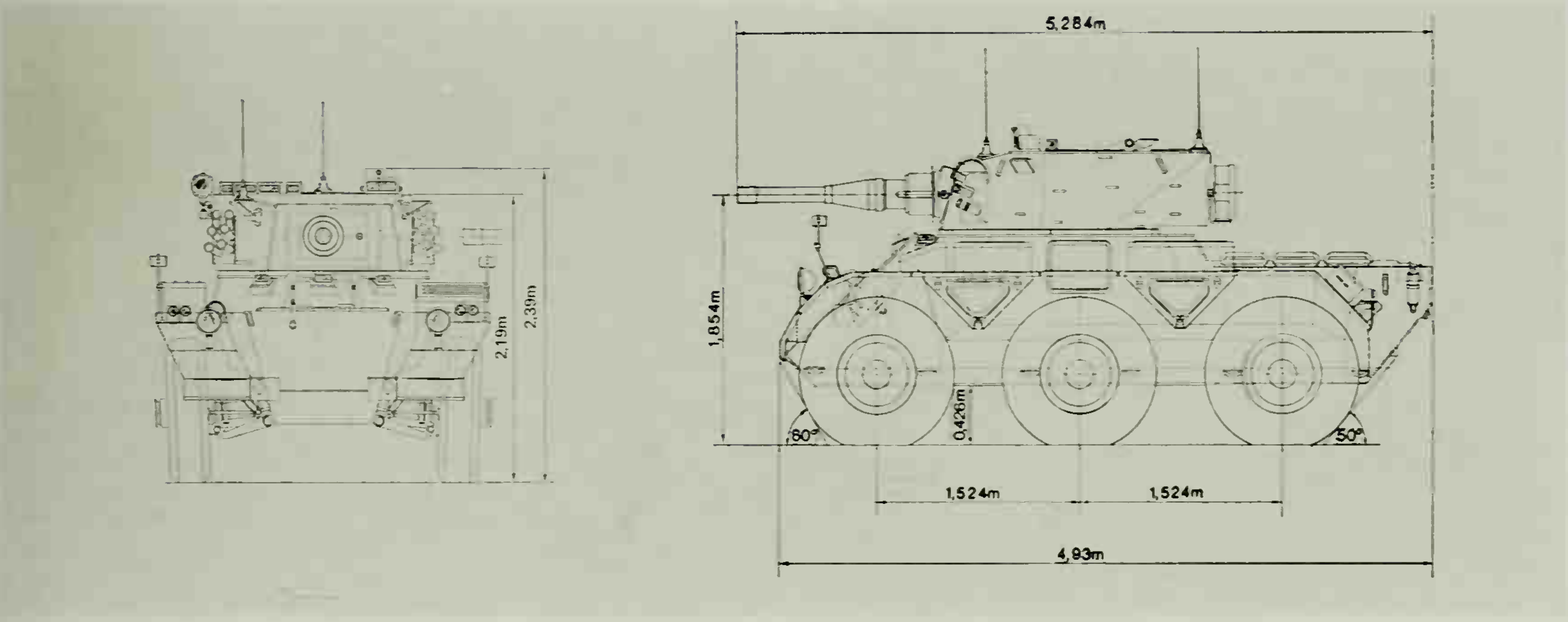
High-explosive squash-head (HESH): anti-tank, effective against medium tanks and light armoured fighting vehicles at all ranges when a hit is obtained. It can demolish concrete, earthworks, buildings and field defences. Its lethality against troops in the open is close to that of orthodox high-explosive shells.

High-explosive: good fragmentary attack up to 5000m.

Smoke: base ejection.

Two Browning machine guns are mounted, one parallel with the 76mm gun, the other on a commander's mounting for use in the ground and anti-aircraft roles.

The vehicle is powered by the B80 Rolls-Royce military gasoline engine; the drive is taken to all six road wheels. Steering is power-assisted on the front and centre (four) wheels.



Specification

Dimensions
Max height: 2·38m (7ft 10in)
Max width: 2·54m (8ft 4in)
Max length, gun front 5·28m (17ft 4in); gun rear 4·93m (16ft 2in)
Tracks: 2·03m (6ft 8in)
Wheelbase front to centre: 1·52m (5ft); centre to rear 1·52m (5ft)
Ground clearance: 0·44m (1ft 4⅜in)

Fire power
76mm main armament, with 0·30-in Browning parallel-mounted; elevation +20° to –10°; traverse 360° hand and power-assisted
0·30-in Browning commander's for ground and AA roles
76mm fixed ammunition—HESH, HE, Smoke, SH/PRAC
12 smoke dischargers mounted on turret
Sights, gunner: one periscope x6
Vision, commander: five periscopes x1; driver one periscope x1

Protection
Although less than that of a tank, adequate protection is given against mines, mortar and field artillery splinters, small arms ball and AP attack, nuclear blast and heat flash
Turret: 32mm/15° front; 16mm side and rear; and 10mm roof
Hull: 12mm/45° glacis; 14mm/42° nose; 16mm/20° side and rear; 10/12mm roof; and 8/12mm floor

Replenishment
Capacities, ammunition: 76mm, 42 rounds; Browning, 2750 rounds (boxed); smoke, 24 cannisters; grenades, hand, 9; and carbine, 160 rounds
Fuel: 241 litres (53gal)

Mobility
Max speed: 72km/h (45mph)
Average max roads: 161km (100miles): 48km/h (30mph)
Average cross-country: 32km/h (20mph)
Vertical step: 0·46m (1ft 6in)
Max gradient: 24° (42%)
Trench: 1·52m (5ft)
Angle of approach: 60°
Angle of departure: 50°
Turning circle: 14·63m (48ft)
Angle of tilt: 45°
Fording, no preparation: 1·07m (3ft 6in); with kit: 2·13m (7ft)
Swimming, with kit, wheel propulsion: 4km/h (2·5mph); exit bank: 20°; entry bank: 25°
Battle weight: 11 580kg (11 ton 8cwt)
Bridge classification: 10
Airportable at: 11 566kg (25 550lb)
BHP/ton, gross: 12·25
Ground pressure (with British Army 12·00 tyres): 1·12kg/cm² (15·9lb/in²)

Communications
Supply: 24V, 75A two-speed generator, two 24V 60Ah batteries
Radio: British Army fit C13/B47. Vehicle fully screened to receive any combination of sets as nominated by the customer

Engine
Rolls-Royce B80, 8-cylinder; max bhp 160 at 3750rev/min; max torque 39kg m (280lb ft) at 2250rev/min, dry sump lubrication with full-flow oil filter

Transmission
Coupling: Daimler fluid coupling
Gearbox: Daimler epicyclic pre-selective five-speed
Overall ratios (engine to road wheels): 1st 103·20:1; 2nd 47·50:1; 3rd 26·60:1; 4th 16·20:1; and 5th 10·05:1

Lubricants
NATO and available world-wide from established international oil companies

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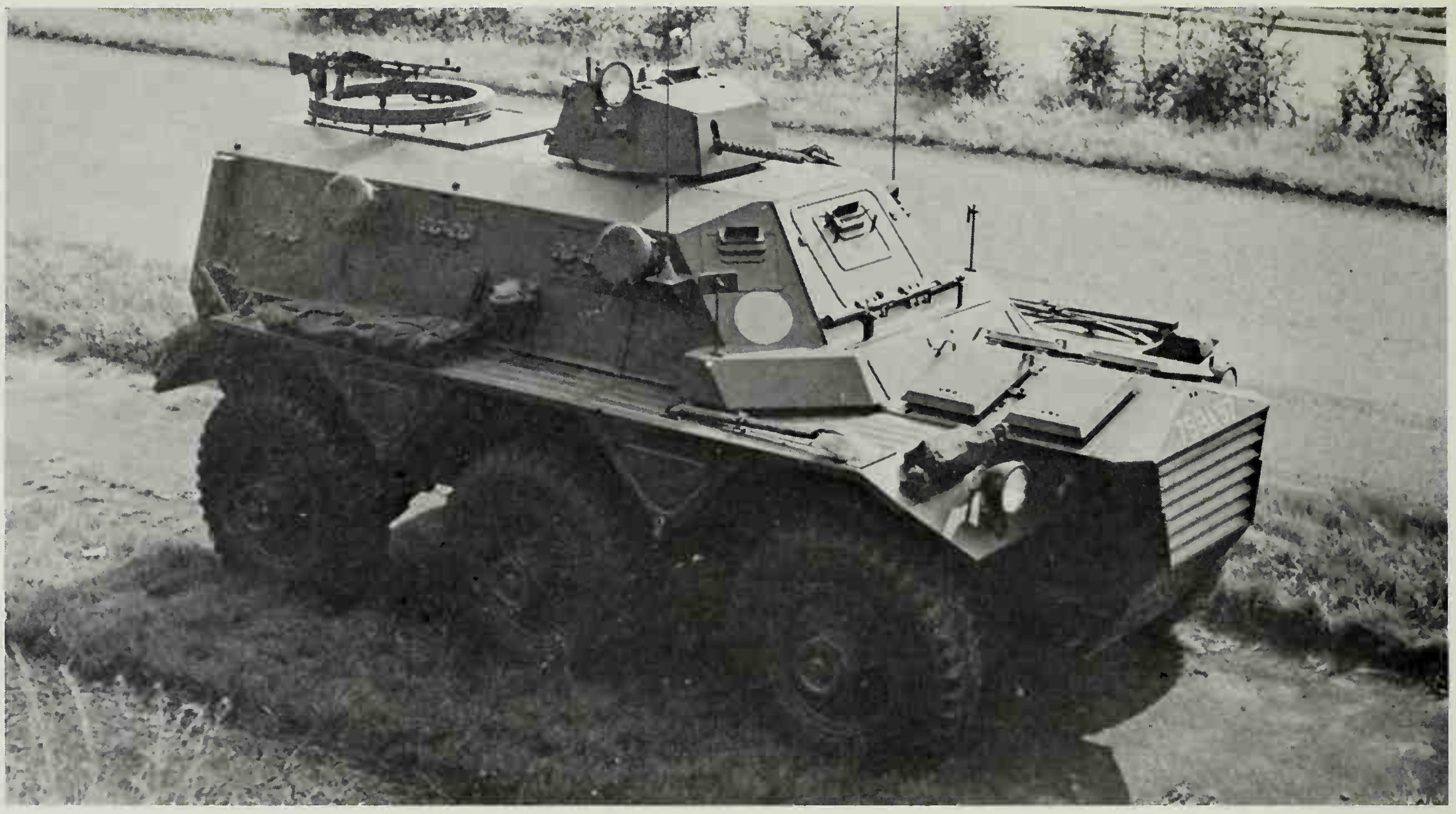
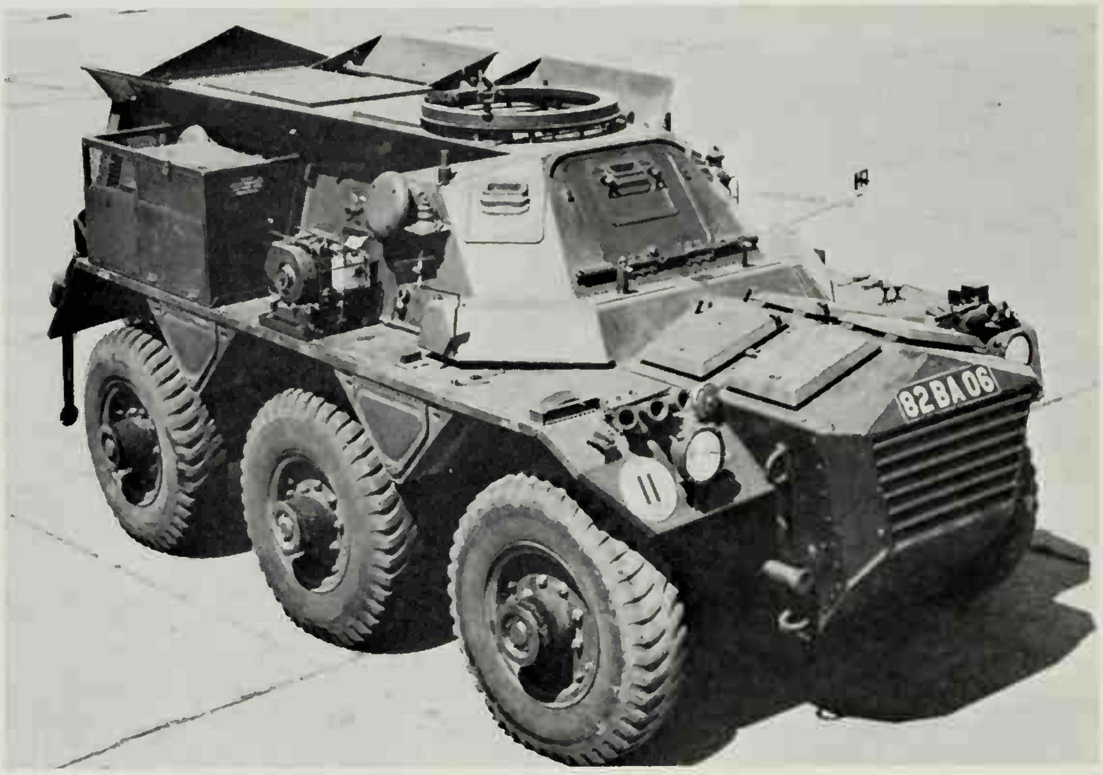
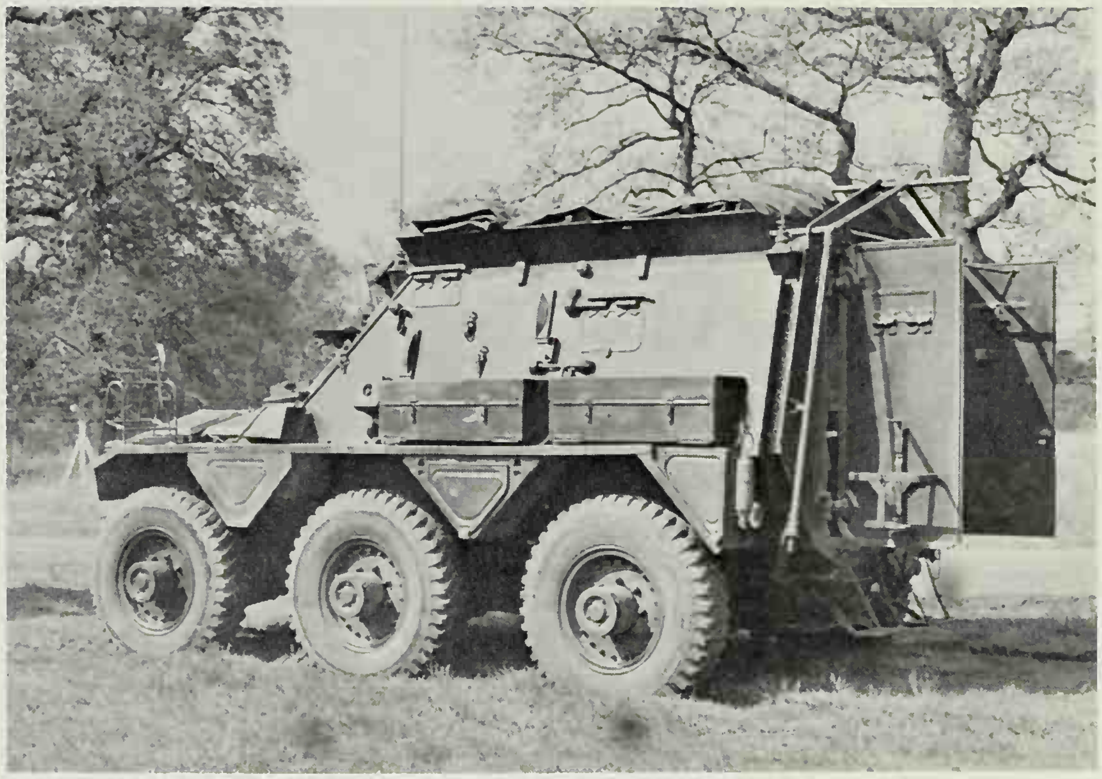




The great versatility of the basic Saracen design is shown by two variants. The Saracen FV604 is basically the same as the FV603, but is modified internally to receive a combination of radio sets suitable for regimental commanders, with seating accommodation for driver, commander, radio operators and command staff. Stowage is provided for wall maps and operational documents, etc. External fittings include attached tentage to enable a command post to be established when the vehicle is static.

Additional external stowage includes extra batteries and an auxiliary charging plant. The vehicle can be converted into a static command post within minutes and, conversely, re-stowed and made mobile with the minimum delay. The stowage specification can be modified to meet customers' requirements



The Saracen FV610, again basically the same vehicle as the troop carrier, was originally designed as a Royal Artillery vehicle GPO/CPO. It has since been adapted for use as a command post for regimental/brigade/division headquarters. As this vehicle is intended to be used in the static role for longer periods than the FV604 the height has been increased to permit standing room and widened to permit the installation of additional radio sets and equipment. Extra charging facilities are provided to cater for additional radio sets, and the attached tentage has been increased to give covered protection for large order groups and conferences

Saracen

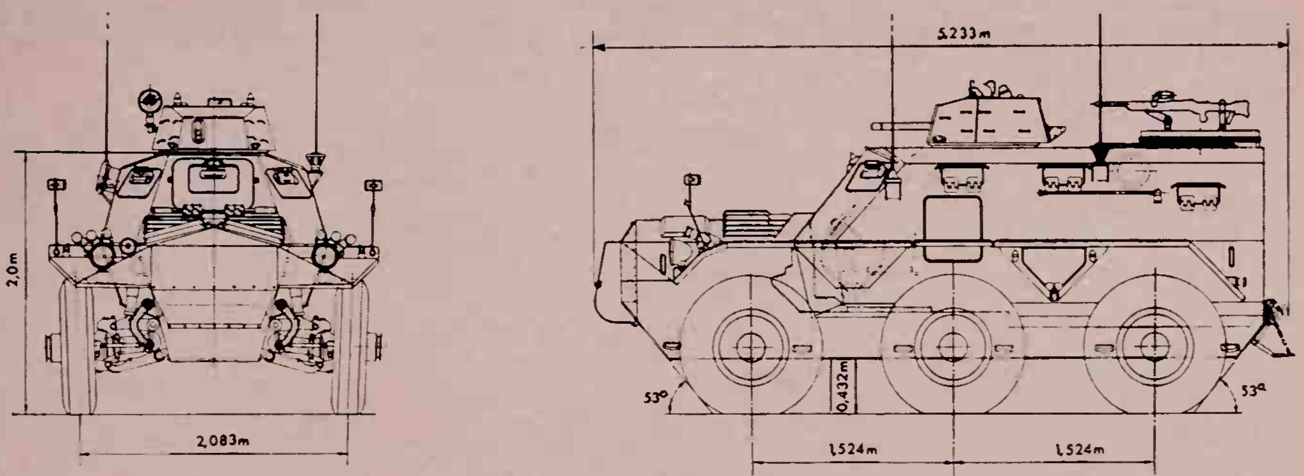
armoured troop carrier and command vehicle

Basically intended as an armoured troop carrier, the Saracen has also proved its worth in world-wide service as an armoured ambulance, command vehicle, fitters' vehicle, radio carrier, and as various forms of cargo vehicle for the carriage of engineering and other equipment.

Its extreme mobility in the roughest of country makes its performance comparable with that of much heavier tracked vehicles, yet an exceptionally low noise factor makes it the ideal vehicle for surprise operations, especially at night. Internally, this low noise factor also helps to keep troops fresh and in fighting condition, even over long distances. With special equipment, fording is possible to a depth of almost 2m (6ft 6in).

Troops are adequately protected against mines, mortar and field artillery splinters, small arms fire, and AP attack, nuclear blast and heat flash. For defensive purposes a 0·30-in Browning machine gun is mounted in a 360deg traverse one-man turret. Saracen is also provided with a ring mount for an external light machine gun. Eight hinged ports are positioned to give infantry maximum scope for the firing of personal weapons. Six smoke dischargers are also mounted.

Saracen has already proved itself in all types of terrain, from jungle to desert, and in all climatic conditions. Adaptable to many different military and policing roles, it is particularly valuable when quick infantry strikes are needed, or for following up and consolidating mobile armoured operations.



Dimensions

Max height: 2·463m (8ft 1in)
Max width: 2·54m (8ft 4in)
Length: 4·85m (15ft 11in)
Max length, over tow-hook: 5·03m (16ft 6in)
Max length, reverse flow coding: 5·23m (17ft 2in)
Track: 2·08m (6ft 10in)
Wheelbase, front to centre: 1·52m (5ft)
Wheelbase, centre to rear: 1·52m (5ft)
Ground clearance: 0·43m (1ft 5in)

Specification

Fire power
0·30-in Browning machine gun in one-man turret
Elevation +45° to −15° over an arc of 180°
Traverse 360° (hand-operated)
Ring mount for one external light machine gun (infantry squad weapon)
Six smoke dischargers mounted on front mudwings
3000 machine gun rounds stowed in vehicle
Infantry can fire personal weapons through eight vision/firing ports in the hul
Vision: Commander has one sight periscope No 3 Mk 1; driver has three No 17 periscopes

Protection
Adequate protection is given against mines, mortar and field artillery splinters, small arms ball and AP attack, nuclear blast and heat flash
Turret: 16mm/10° front; 10mm/15° side; 8mm/13° rear; and 8mm roof
Hull: 12mm/40° glacis/visor; 10mm/40° nose; 12mm/20° side; 8mm roof; and 12mm floor

Mobility
Max speed—road forward: 72km/h (45mph)
Average cross-country: 32km/h (20mph)
Vertical step: 46cm (1·5ft)
Max gradient: 24° (42%)
Trench: 1·52m (5ft)
Angle of approach: 53°
Angle of departure: 53°
Turning circle: 13·72 ±1·52m (45ft ±5ft)
Angle of tilt: 45°
Fording—no preparation: 1·07m (3ft 6in); with kit 1·98m (6ft 6in)
Battle weight: 10 413kg (10¼ ton)
Bridge classification: 10
Airportable at:10 160kg (22 400lb)
BHP/ton: 16·1
Ground pressure (with British Army 12·00 tyres): 0·98kg/cm² (14·0lb/in²)

Communications
Supply: 24V 25A two-speed generator; two 12V 60Ah batteries
Radio: British Army fit C42/B47 or C13/B47. Vehicle fully screened to receive any combination of sets as nominated by the customer

Engine
Rolls-Royce B80, 8-cylinder
Max bhp 160 at 3750rev/min (gross)
Max torque 39kg m (280lb ft) at 2250rev/min
Dry sump lubrication with full-flow oil filter

Transmission
Coupling: Daimler fluid coupling
Gearbox: Daimler epicyclic pre-selective five-speed
Overall ratios (engine to road wheels): 1st 103·20:1; 2nd 47·50:1; 3rd 26·60:1; 4th 16·20:1; and 5th 10·05:1

Lubricants
NATO and available world-wide from established international oil companies

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ALVIS

Stalwart is powered by the 220 hp B81 Rolls-Royce engine, with a rugged twin-plate clutch and five-speed gearbox. This transmission makes it possible for one Stalwart, even when fully laden, to tow a laden sister vehicle. A no-spin differential is also fitted, and special self-drying disc brakes to give highly efficient stopping power even after the vehicle has been swimming.

All mechanical components are below the cargo floor. All replenishment points are accessible without the need to disturb the cargo. No preparation or servicing is required before and after swimming. Both sides and rear doors can be lowered for loading and off-loading. The height of the cargo floor is virtually the same as that of the engine deck of all Western tanks, thus easing fatigue in the combat area. Approximately 35 fully armed troops can be carried over land and water. A built-in winch is fitted on all vehicles built to British Army standards.

A hydraulic jib can be mounted as an extra item for self-loading purposes. The vehicle can carry all types of NATO and Western palletised loads. The cargo remains dry when swimming, and can be loaded, or off-loaded, ship-to-vehicle. Drivers of conventional 'B' vehicles can be trained to operate Stalwart in one week.

Fuel, coolant, engine lubrication, and hydraulic replenishment can be carried out while the vehicle is afloat.

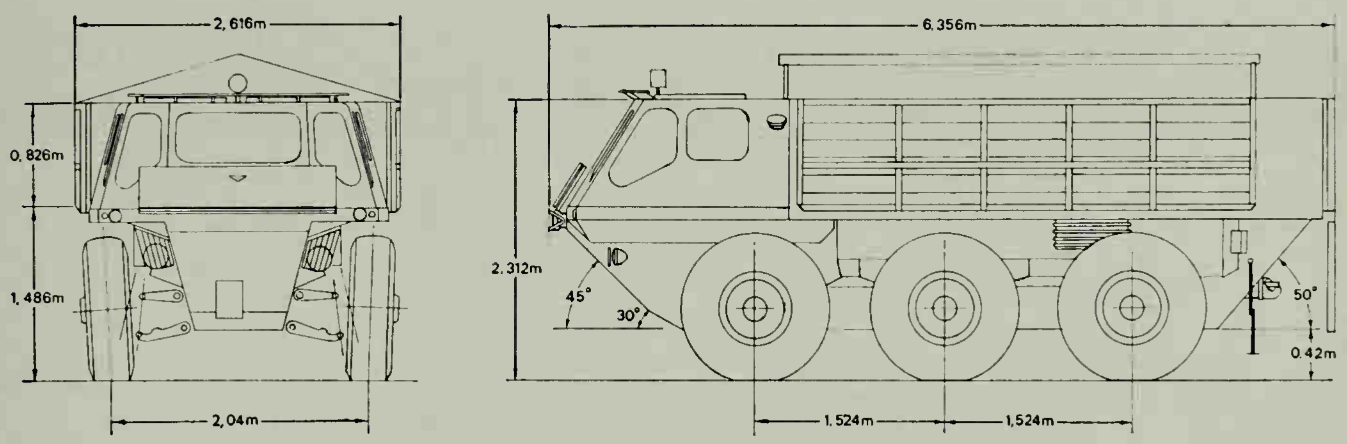
Stalwart

high-mobility load carrier

The Stalwart is the latest member of the FV600 family of vehicles, introduced into the British Army in 1966 following six years of development and user trials in the United Kingdom, Germany and Aden. These trials proved without question the superiority of Stalwart as a logistic vehicle, to the extent that it is now being issued to all armed services as the general-service 5-ton high-mobility load carrier, as the artillery limber for self-propelled guns, and as a recovery vehicle; it has even been found suitable for ship-to-shore replenishment. It is three vehicles in one—a conventional road vehicle, a cross-country vehicle capable of reaching tanks under all terrain conditions, and an amphibian capable of water speeds exceeding 5 knots in open sea conditions. It is the most advanced load carrier in service in the Western World.

The advantage of Stalwart over all other amphibious vehicles is the combination of independent wheel and water propulsion and its excellent angles of approach and departure, thus permitting it to enter and leave the water by using both water and wheel propulsion, and without the disadvantage of an extended bow and stern. Stalwart is equipped with the standard NATO towing attachment and trailer brake air lines, which permit it to tow guns and all types of military trailers up to 10 tons laden weight.

The British Ministry of Defence and Alvis Limited will give the maximum advice and assistance to anyone planning or organising base workshop repair facilities. Technical literature to the full British Army standard is made available by the Ministry of Defence. A spares scaling will be prepared to suit customers' requirements. Alvis Limited guarantee the supply of spares throughout the service life of the vehicles, and the British Ministry of Defence maintain special stocks of spares for overseas customers.



Dimensions
Overall length: 6·35 m (20 ft 10¼ in)
Overall width: 2·62 m (8 ft 7 in)
Overall height (unladen): 2·64 m (8 ft 10 in)
Ground clearance
(laden): 0·42 m (1 ft 4½ in)
Cargo area: 8·77 m^2 (94·5 ft^2)
Cargo capacity: 7·25 m^3 (256 ft^3)
Loading bed height: 1·5 m (58⅝ in)
Wheelbase: 3·05 m (10 ft)
Track: 2·11 m (6 ft 8 $\frac{5}{16}$ in)

Specification

Protection
The basic vehicle is unarmoured. An armoured cab can be fitted to meet customer requirements. The vehicle configurations protect the crew and load from mines. The vehicle is capable of continued operation with two wheels blown off

Mobility
Max speed—land: 64 km/h (40 mph)
Max gradient surmountable: 24° (44%)—laden
31° (60%)—unladen
Range (road use): 640 km (400 miles)
Retardation: 0·60 G
Vertical obstacle: 0·46 m (1 ft 6 in)
Trench crossing: 1·52 m (5 ft)
Turning circle: 16·76 ±1·52 m (55 ft ±5 ft)
Side overturn angle: 34° laden (load 1·07 m^2/ton (38 ft^2/ton))
Angle of approach: 44° 30' unladen; 44° 0' laden
Angle of departure: 40° 15' unladen; 35° 0' laden
Fuel consumption: 70·6 litres/100 km (4 mpg) at average safe road speed
Fording—no preparation: to full flotation
Swimming—max. speed with propulsion units: 10·2 km/h (6·4 mph) unladen; 9·6 km/h (6·0 mph) laden
Exit bank: unlimited using winch; entry bank: vertical
Battle weight (laden): 13 500 kg (29 813 lb)
Bridge classification: 14
Airportable at: 8837 kg (18 600 lb)
Gross bhp/ton: 16·5
Ground pressure (with British Army 14·00 tyres): 1·04 kg/cm^2 (14·9 lb/in^2) laden; 0·86 kg/cm^2 (12·3 lb/in^2) unladen

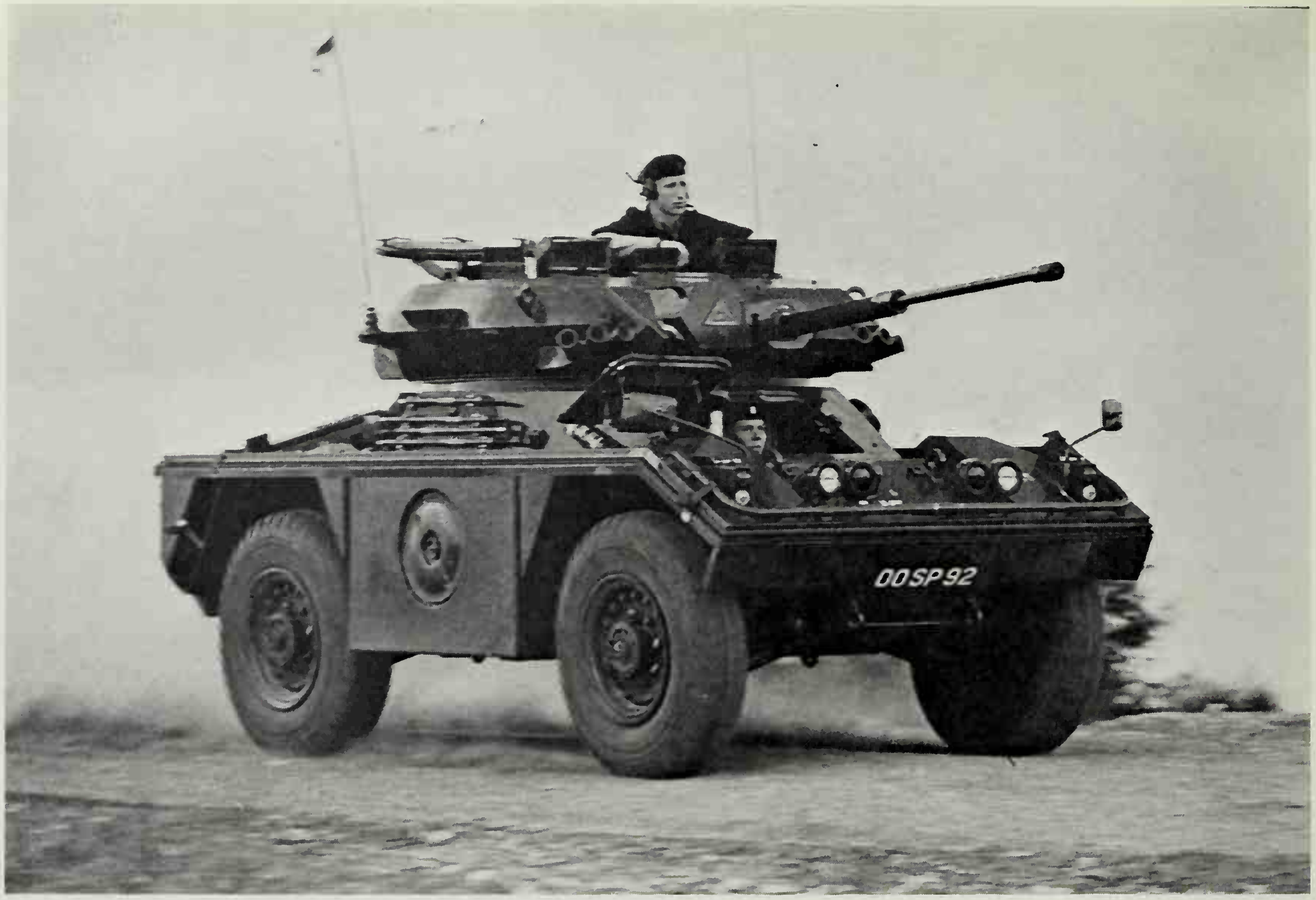
Communications
Supply: 28·5 V, 90 A, two-speed alternator; two 12 V, 100 Ah batteries
Radio: as per customer requirements

Engine
Rolls-Royce B81, eight-cylinder petrol
Max bhp 220 at 4000 rev/min (capacity 6·522 litres)
Max torque: 46 kg m at 2750 rev/min (330 lb ft) gross
Dry sump lubrication with full-flow oil filter

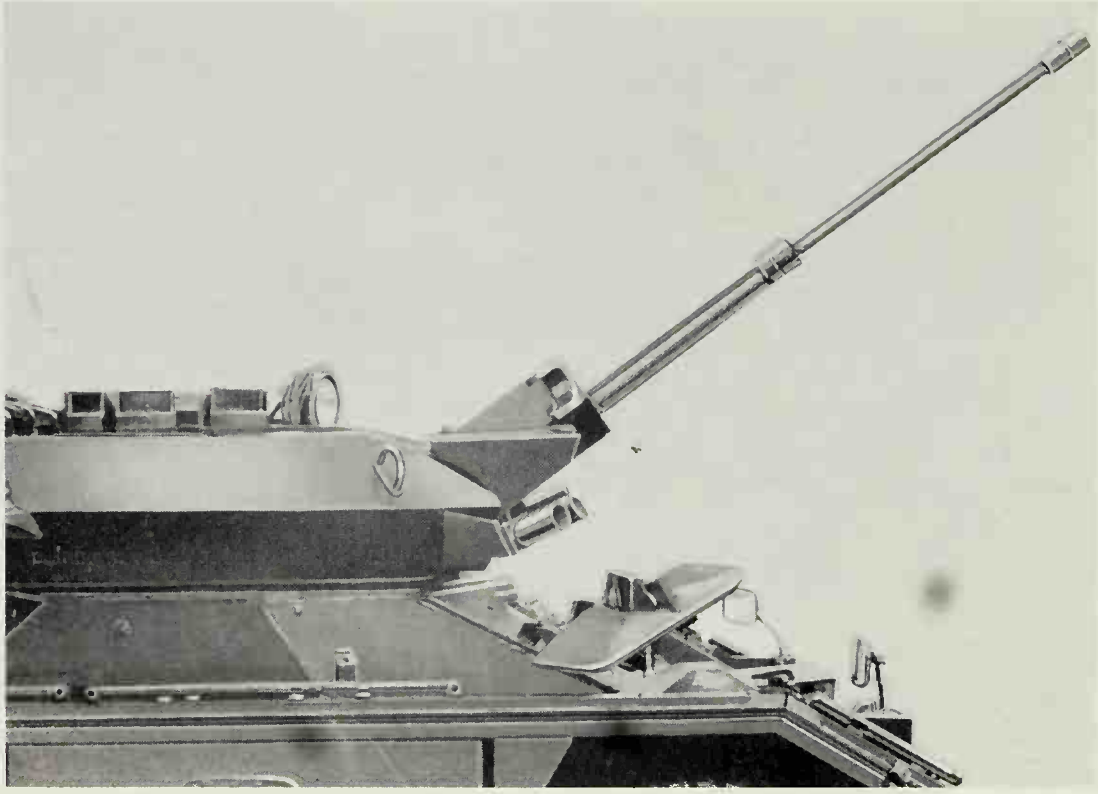
Transmission
Gearbox: five forward gears, syncromesh with the exception of 1st gear, incorporating power take-off for propulsion units and winch pump drive
Overall ratios (engine to road wheels): 1st 103·28:1; 2nd 53·82:1; 3rd 33·24:1; 4th 19·82:1; and 5th 12·90:1

Lubricants
NATO and available world-wide from established international oil companies

ALVIS LIMITED
Holyhead Road, Coventry, CV5 8JH, England
Telephone: Coventry 25501 Cables: Alvis Coventry Telex Telex: 31459



Fox accommodates a crew of three: driver, gunner/operator and commander/loader. All controls and ancillary equipment are suitably grouped to ensure ease of reach by one man, if necessary. The crew compartment is thermally insulated and designed with maximum crew comfort and safety in mind



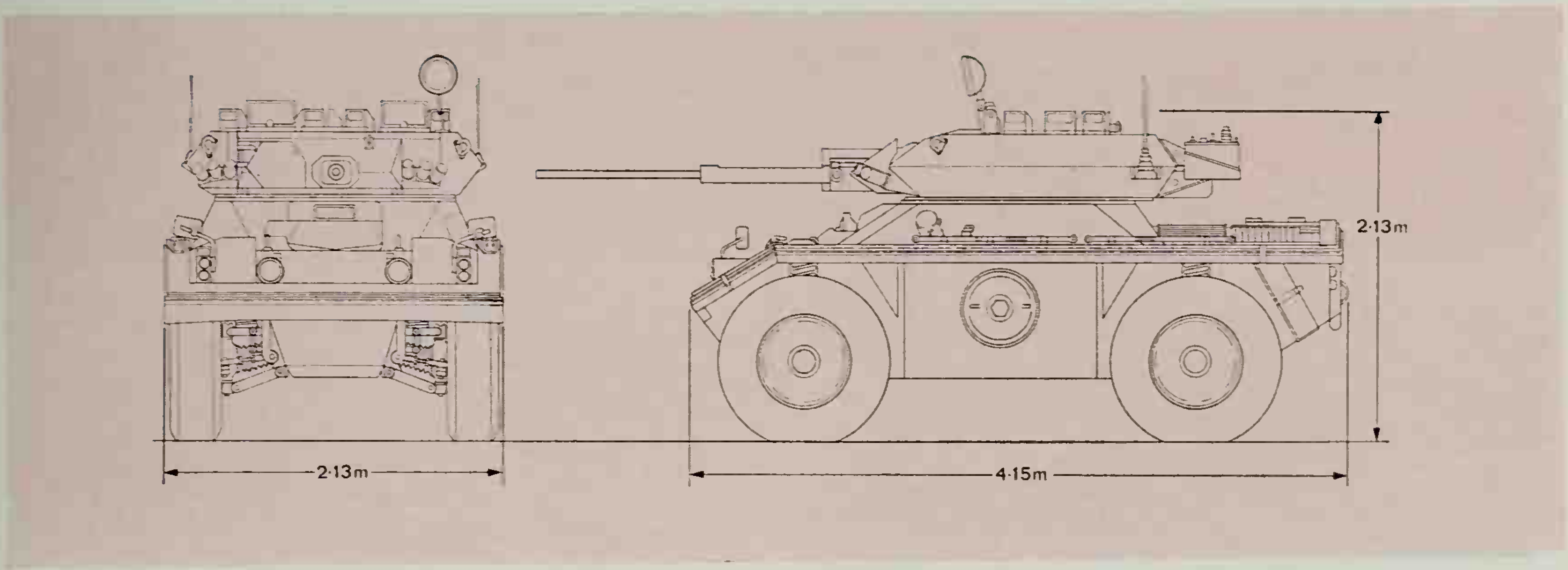
The Rarden 30 mm cannon is a new and versatile light weapon of exceptional power and accuracy described in detail elsewhere in this catalogue. It has a destructive power usually found only in heavier weapons. It can destroy any known or foreseen light armoured fighting vehicle from a range of over 1000 m and, loaded with other improved natures of ammunition now under development, will penetrate heavy armour. Loaded with high-explosive shell it can deal effectively with soft targets such as men under cover, trucks, and, thanks to an elevation of +40° (+711 to −250 mils) with low-speed aircraft

Fox

armoured car

Fox, one of a new family of armoured vehicles and a logical development of the well-proven Ferret, is designed to meet the need for a lightweight armoured reconnaissance vehicle of compact proportions capable of undertaking a wide variety of roles, including some which previously required larger and heavier vehicles. Apart from armed reconnaissance, the extremely versatile Fox can be adapted for liaison use with the infantry, artillery, engineers and other branches of the armed forces. In its main role, Fox can be equipped with a 30 mm cannon, a 7·62 mm general-purpose machine gun, smoke dischargers, three 9 mm sub-machine guns, hand grenades and comprehensive sighting and vision instruments. Fox is extremely manoeuvrable and, with its exceptionally high power/weight ratio, has excellent cross-country characteristics. Fox can cross water 91 cm (3 ft) deep without preparation and is supplied with flotation equipment which is easily and quickly brought into operation for swimming under its own power.

The power unit and auxiliaries are specially mounted to facilitate complete unit withdrawal for ease of maintenance. Fox is designed to operate in climatic conditions from −40° to +50°C. In addition, Fox is air-portable (three can be carried in the Hercules C Mk 1 aircraft) and, using special equipment, two can be parachute-dropped. These and many other features combine to make Fox one of the most outstanding wheeled combat vehicles in the world.



Specification

Protection
The turret and hull are of light-alloy armour and give protection against medium and heavy machine gun attack, from ground burst to air burst shell splinter, and minimise crew injury from anti-tank mines

Armament
Elevation: +40° to −14° (+711 to −250 mils)
Main armament: 30 mm Rarden cannon, with single-shot or burst capability, firing 30 mm Hispano 831L ammunition
Parallel armament: 7·62 mm general-purpose machine gun
Smoke: two 3-barrelled dischargers
(Main armament, machine gun and smoke dischargers are electrically operated but have manual overriding control)

Air transportation
Fox vehicles can be transported in Hercules C Mk 1 aircraft and two vehicles per aircraft can be parachute-dropped using a special lightweight platform and parachute equipment

Engine
Type: Jaguar XK 4·2 litre (militarised)
Capacity: 4,200 cm³
Number of cylinders: 6
Max horsepower: 195 bhp (197·7 cv) at 5000 rev/min
Max torque: 372 kgf m (250 lbf ft) at 3500 rev/min

Transmission
Engine gearbox coupling: Daimler fluid flywheel
Gearbox: Daimler pre-selective epicyclic five-speed unit
Transfer box: Daimler spiral bevel directional control gears and double-helical drop-down gear to a limited-slip differential provide, in combination with the gearbox, five forward and five reverse speeds, and drive to all four wheels

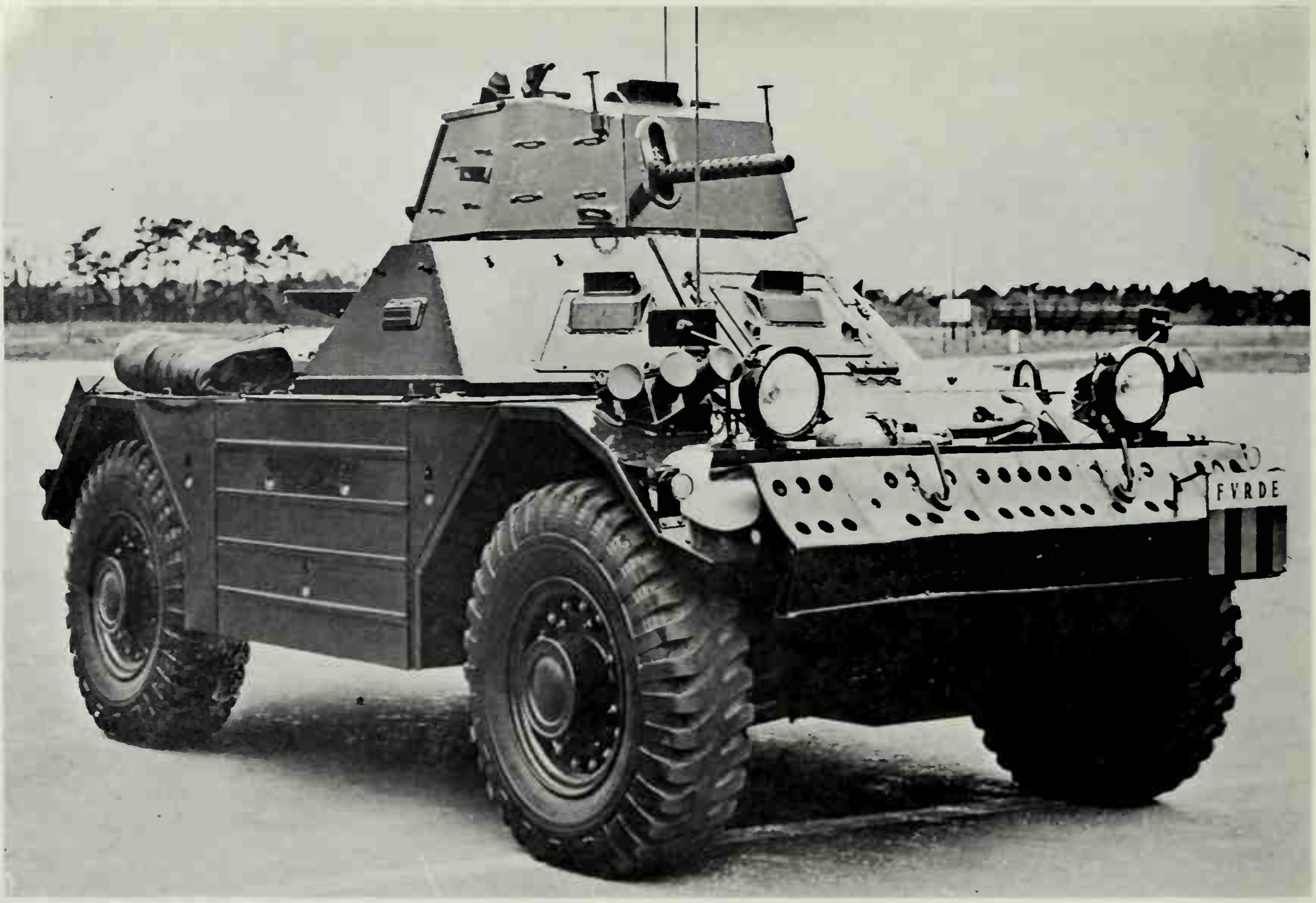
Gearbox ratios
Top 1·000:1, 4th 1·569:1, 3rd 2·437:1, 2nd 4·381:1
Transfer box ratio: 1·347:1
Bevel box ratio: 1·923:1
Hub reduction ratio: 3·500:1
Overall ratios: top 6·217:1, 4th 9·754:1, 3rd 15·150:1, 2nd 27·240:1 1st 37·580:1

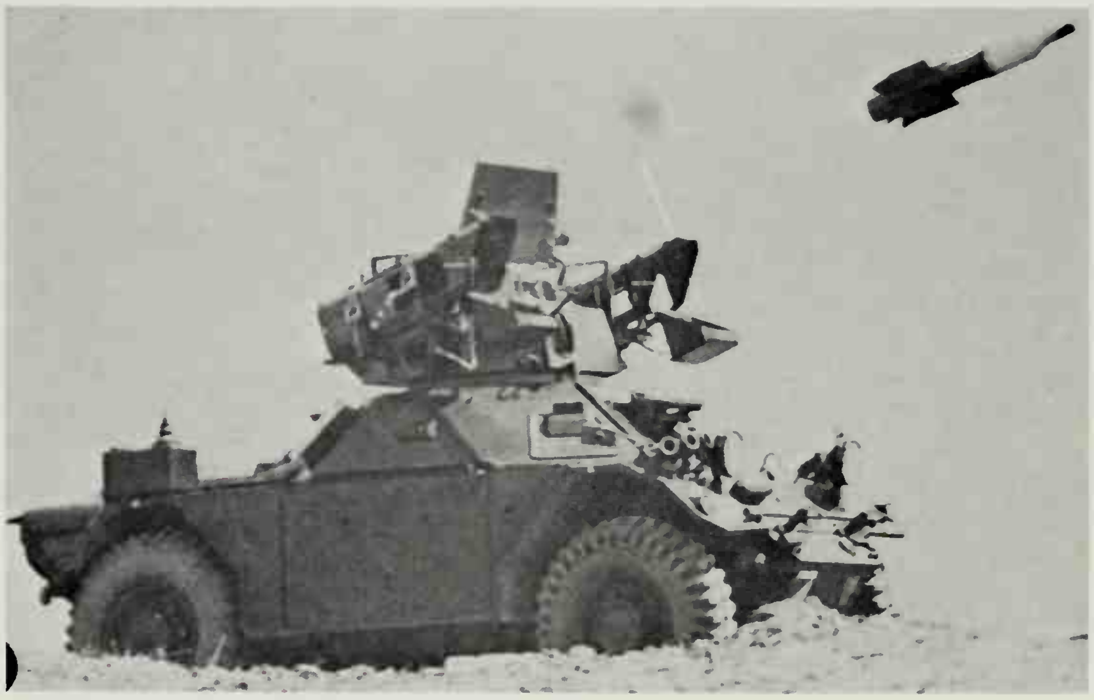
Tyres
Lightweight high-speed Run-flat 11·00 × 20 in tyres on light-alloy wheels. Cross-country or sand type tread patterns are available

Steering
Power-assisted steering

Brakes
Lockheed twin caliper disc brakes, power-assisted and hydraulically operated. Transmission handbrake

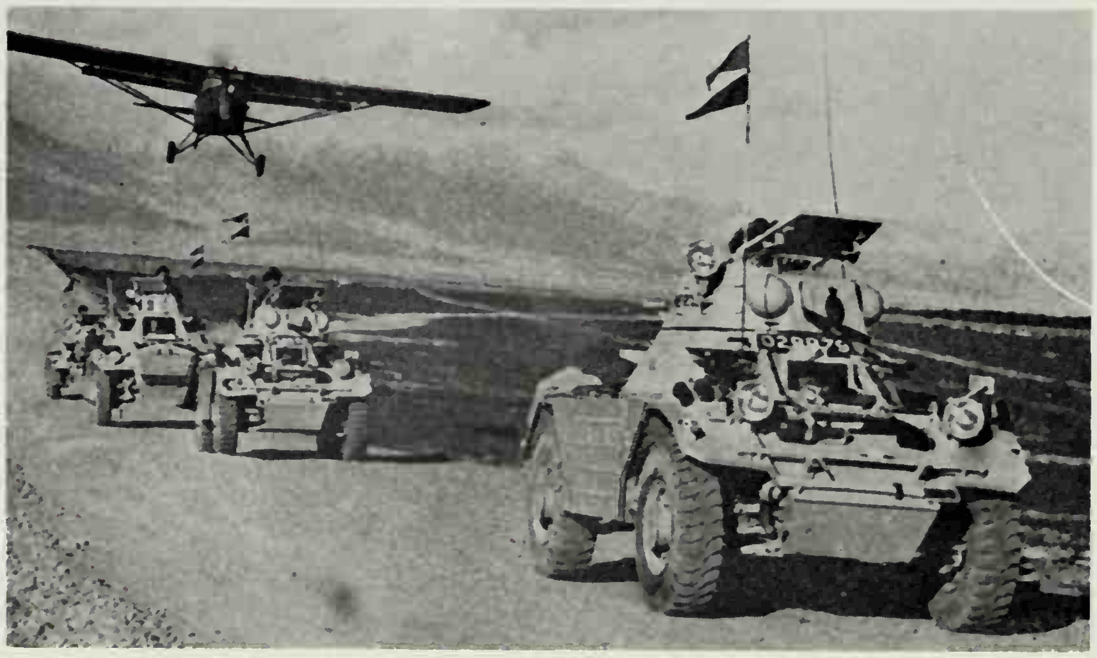
THE DAIMLER COMPANY LIMITED
Daimler Road, Radford, Coventry, England
Telephone: Coventry 27626 Cables: Daimler Coventry Telex: 31459





During the Second World War thousands of Daimler scout cars proved themselves in theatres of operation all over the world. The actual combat experience thus gained led to the development of Ferret as the most efficient high-speed liaison and reconnaissance vehicle in military service today. The basic Ferret Mk 1 is a liaison vehicle identical in specification to Mk 2, except that it is not fitted with a turret

With its lively performance, excellent cross-country characteristics, and extremely low silhouette, the Ferret has all the qualities essential in the scouting and reconnaissance roles. The addition of special equipment enables it to fire four Vigilant anti-tank guided missile and turns it into a deadly and highly mobile combat vehicle



The Ferret Mk 2 is identical with the Mk 1, except that it has a manually operated turret mounting a medium machine gun

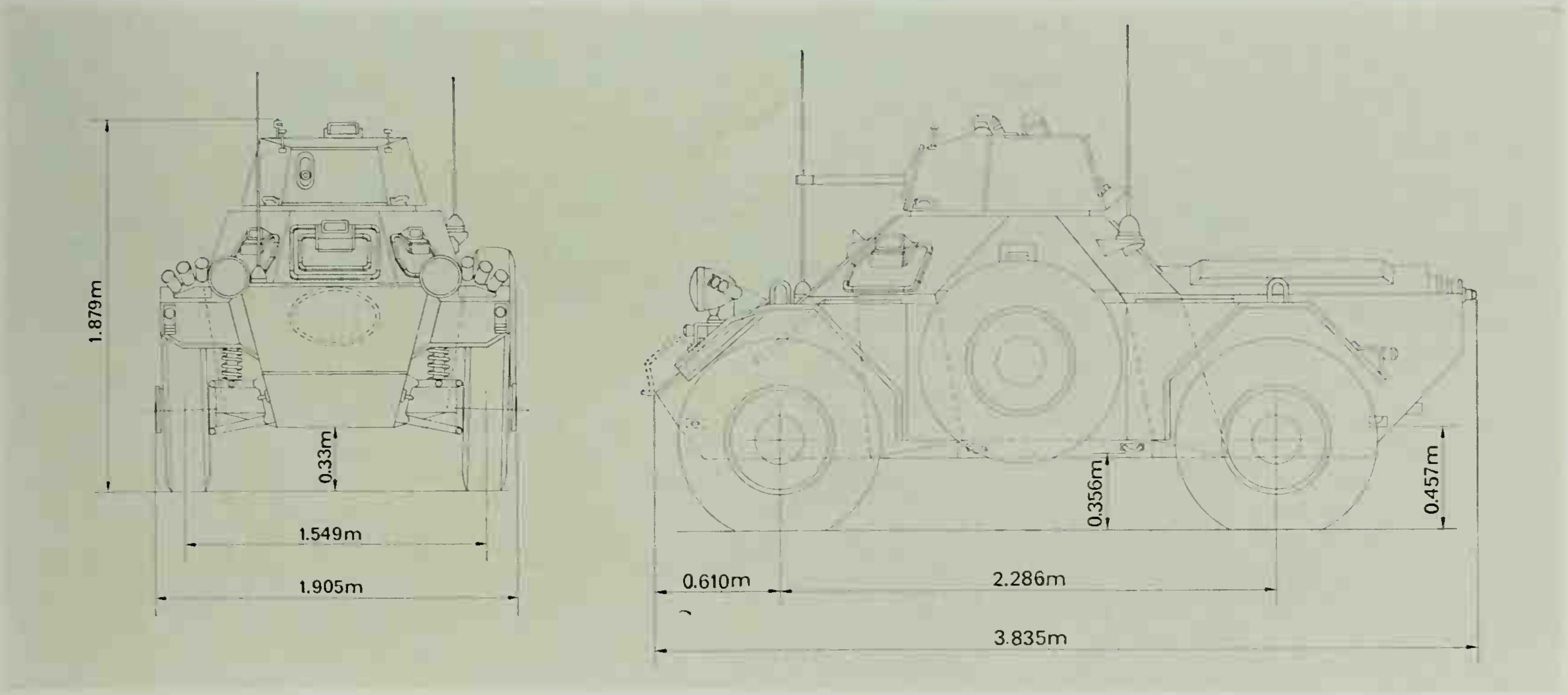
Ferret

scout car Mk 2

In the reconnaissance and scout roles the Ferret Mk 2 has proved itself persistent, quick to appear in the right place at the right moment, and hard to catch when its mission is completed. Multi-barrel smoke dischargers make it possible for the car to provide its own cover in emergency.

Ferret normally carries a two-man crew: driver/signaller and commander/gunner, the latter armed with a 0·30-in Browning machine gun. The manually operated turret gives a traverse of 360deg.

Four-wheel drive and rugged suspension make it possible for Ferret to negotiate obstacles up to 0·39m (1ft 4in) high. It will ford water 0·91m (3ft) deep without preparation, and 1·52m (5ft) deep when specially prepared. The vehicle is air-transportable, and can be dropped by parachute for deep penetration into enemy territory.



Specification

Dimensions
Maximum height: 1·88m (6ft 2in)
Maximum width: 1·905m (6ft 3in)
Maximum length: 3·835m (12ft 7in)
Track (front and rear): 1·549m (5ft 1in)
Wheelbase: 2·286m (7ft 6in)
Ground clearance: 0·33m (13in)

Protection
Protection gives immunity from:
(a) Frontal attack over an included angle of 50deg (890mils) by calibre 0·5in AP at 230m (250yd) range
(b) Attack from any direction on the crew compartment by calibre 7·62mm AP at point-blank range
(c) Attack by anti-personnel mines

Armament
One 7·62mm general-purpose machine gun in turret
Two sub-machine carbines
Two multi-barrel smoke dischargers

Mobility
Maximum road speed forward 93km/h (58mph) at 3750rev/min
Acceleration in top gear from 30 to 60km/h (20–40mph) 20sec
Maximum gradient for stop and restart 24deg
Waterproof depth, unprepared 0·91m (3ft), prepared 1·5m (5ft)
Fuel consumption at maximum safe speed on metalled roads having gradients not exceeding 1 in 12 is 3·3km/litre (9 miles/gal)
Range of action under these conditions 306km (190 miles)

Engine
Make: Rolls-Royce B60 Mk 6A
Bore and stroke: 88·9 × 114·3mm (3·50 × 4·50in)
Number of cylinders: 6 in line, straight vertical, water-cooled, petrol-driven, inlet over exhaust valve engine
Compression ratio: 6·4 to 1
Maximum hp (gross): 129bhp at 3750rev/min (governed)
Maximum torque (gross): 29kgf m (209lbf ft) at 2500rev/min
Coolant capacity: 20·4 litres (4½gal)
Oil capacity: 12·5 litres (2¾gal)
Lubrication: dry sump system

Transmission
Clutch: Daimler fluid coupling
Gearbox: Daimler, driver-controlled, pre-selective epicyclic unit providing five speeds
Transfer box: forward and reverse gear trains having spiral bevel directional control gears with positive dog engagement and a double-helical drop-down gear to a single central bevel-type differential which, in combination with the gearbox, provides five forward and five reverse speeds
Gearbox ratios: top 1·000:1; 4th 1·568:1; 3rd 2·437:1; 2nd 4·381:1; 1st 6·046:1
Transfer box ratio: 1·347:1
Bevel box ratio: 1·923:1
Hub reduction ratio: 2·40:1
Overall ratios: top 6·217:1; 4th 9·754:1; 3rd 15·150:1; 2nd 27·24:1; 1st 37·58:1
Steering: three-track 15·87mm (⅝in) pitch recirculating ball servo system on front wheels
Brakes: 330·2mm dia × 63·5mm (13in dia × 2½in) Lockheed drum pattern, dual leading shoes, servo hydraulic foot-operated and hand-operated mechanical linkage
Tyres: 9·00 × 16 run flat tyres; sand tyres can be fitted if requested

Electrical system
Power supply: 24V (two 12V, 60Ah batteries)
Generators: two-speed (automatic) generator, 25A output at 600rev/min
Wiring: negative earth return
Wireless supply: 24V
Instrument panel: (mph) km/h type panel can be fitted if requested

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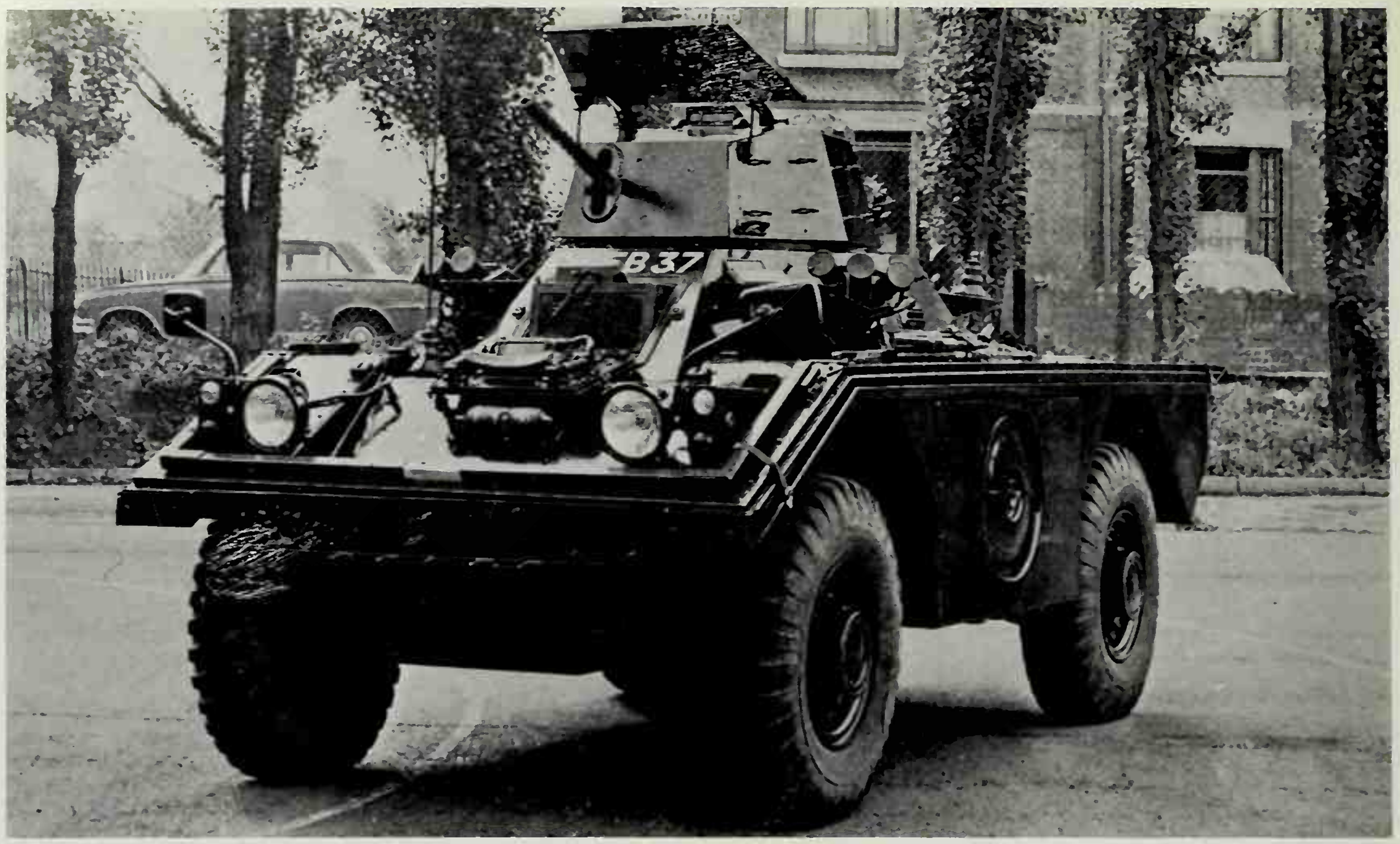
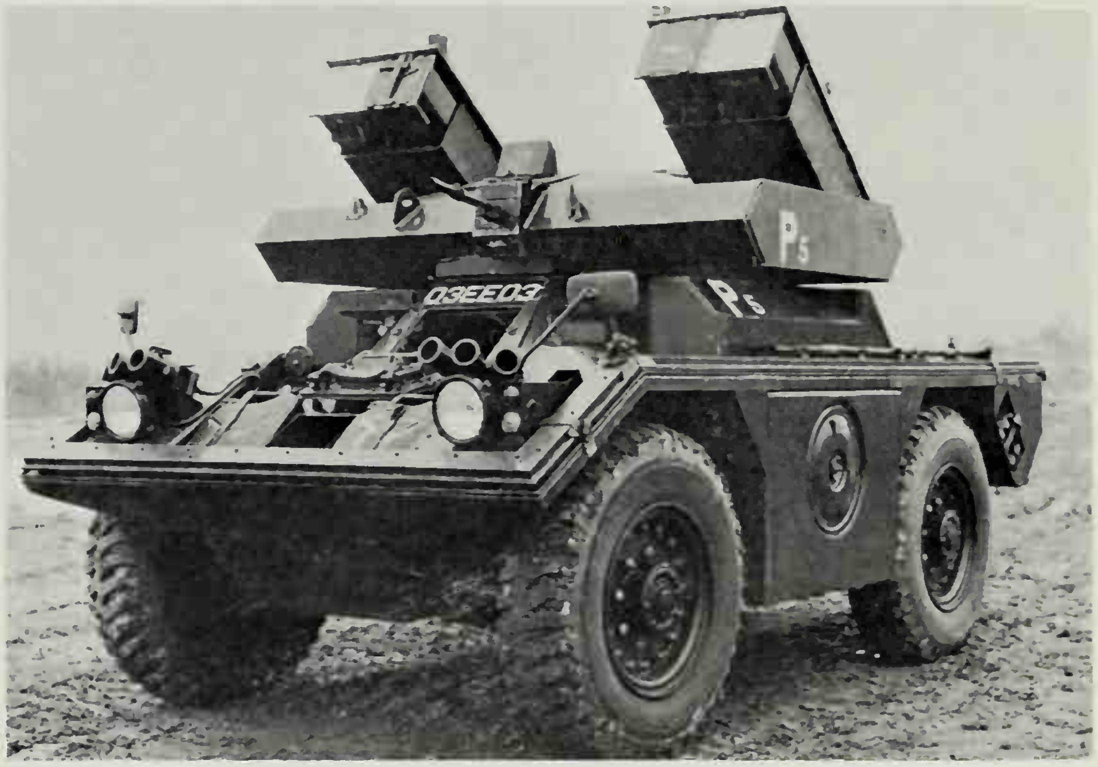
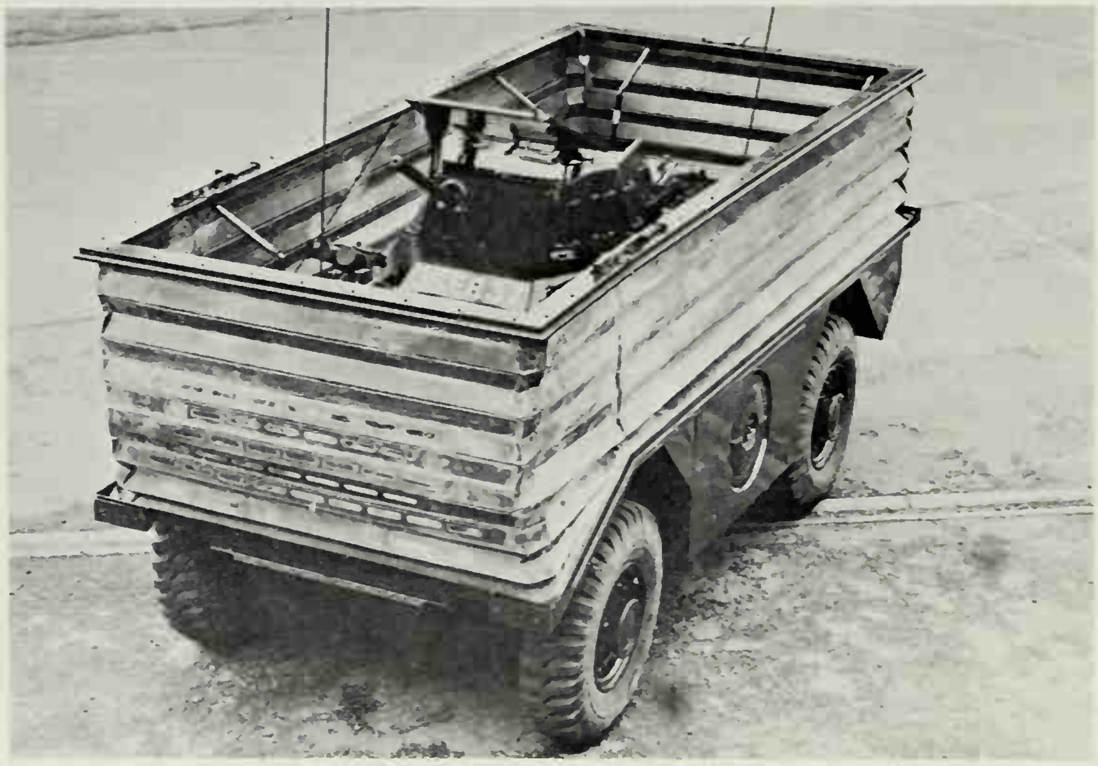




The Big-wheel Ferret Mk 4 has a turret and is fitted with a machine gun and multi-barrel smoke dischargers

The Mk 5 version has a turret with elevating and retractable launchers for four Swingfire missiles, and is fitted with a 7·62mm machine gun electrically operated by the commander



To render the Big-wheel Ferret capable of amphibious operation, a collapsible all-round screen is fitted

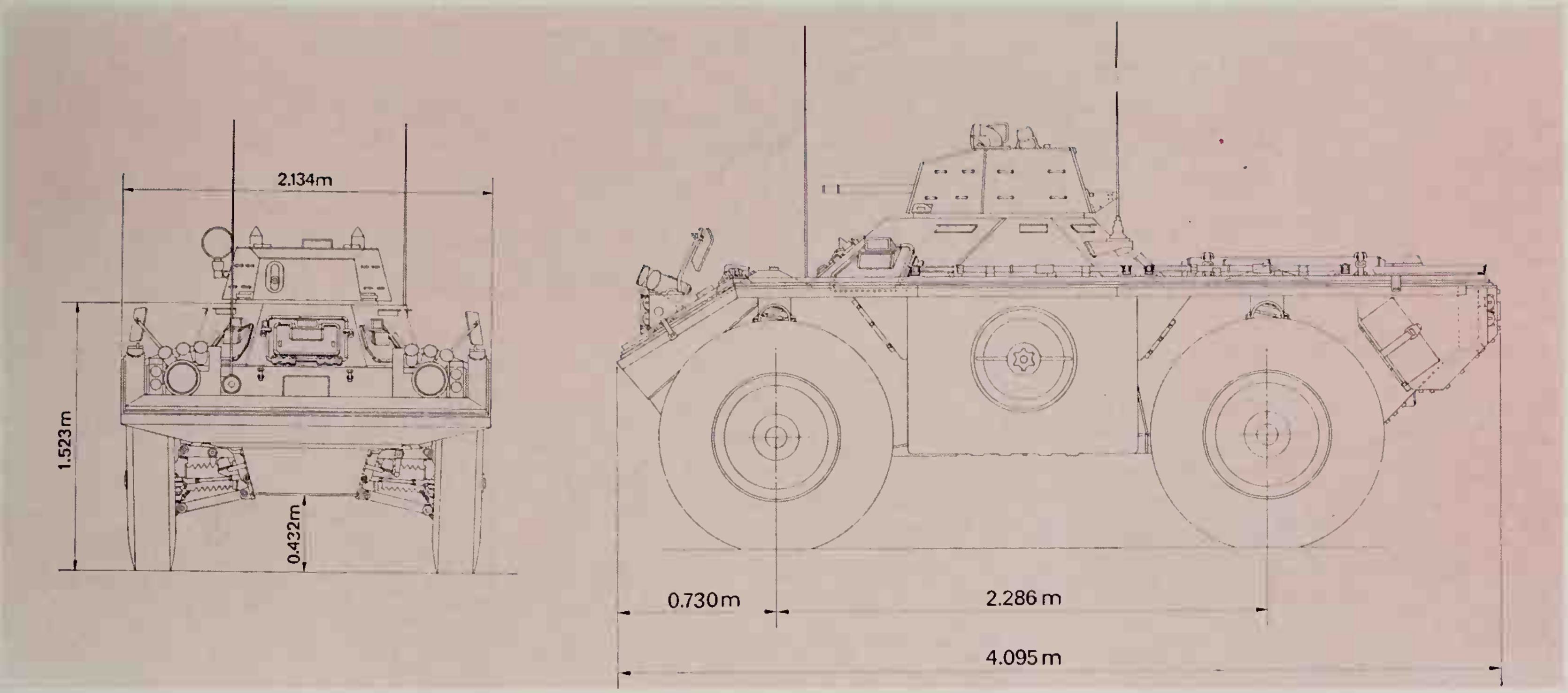
Big-wheel Ferret

scout car Mk 3, Mk 4 and Mk 5

A logical development from the well-proven and highly successful Ferrets Mk 1 and Mk 2, the Mk 3 version has strengthened suspension. This allows for the carriage of more or heavier equipment, and gives vastly improved performance, especially over rough terrain. Like the previous versions, the drive is transmitted to all four wheels.

Ferret Mk 3 is the basic vehicle, with no turret, which can be equipped with a variety of armaments or other equipment to suit military needs. Ferret Mk 4 has an armoured turret with 360deg traverse, fitted with either a 0·303-in Browning machine gun or a 7·62mm GP machine gun. The vehicle is fitted with multi-barrel smoke dischargers.

Ferret Mk 5 is fitted with a special 360deg rotating turret carrying four Swingfire missiles, with elevating retractable launchers. It also carries a 7·62mm machine gun which is electrically operated by the commander.



Specification

Dimensions
Maximum height (Mk 4): 1·98m (6ft 6in)
Maximum height (Mk 5): 2·00m (6ft 7in)
Maximum width: 2·134m (7ft)
Maximum length: 4·14mm (13ft 7in)
Track, front and rear: 1·75 and 1·78m (5ft 9in and 5ft 10in)
Wheelbase: 2·286m (7ft 6in)
Ground clearance: 0·432m (15½in) minimum

Protection
Protection gives immunity from:
(a) Frontal attack over an included angle of 50deg (890mils) by calibre 0·5in AP at 230m (250yd) range
(b) Attack from any direction on the crew compartment by calibre 7·62mm AP at point-blank range
(c) Attack by a mine which will not overturn the vehicle. Protection is provided to minimise the effects on the crew of attack by a larger mine which will overturn the vehicle

Armament
Mk 4: one 7·62mm GP machine gun; two multi-barrelled smoke dischargers; two carbines, stirling
Mk 5: as above plus four Swingfire long-range anti-tank missiles

Mobility
Maximum road speed forward 80km/h (50mph)
Acceleration in top gear from 30 to 60km/h (20 to 40mph): 22sec
Maximum gradient for stop and restart 24deg
Turning circle dia 12·2m (40ft) maximum between kerbs
Waterproof depth, unprepared 1m (3ft 4in)
Swimming with screen erected 3·9km/h (2·4mph)
Entry and departure angle 25deg without shipping water over the top of the screen
Fuel consumption at maximum safe speed on metalled roads having gradients not exceeding 1 in 10 is 2·42km/litre (7·0 miles/gal). Range of action under these conditions 240km (150 miles)

Engine
Make: Rolls-Royce B60
Bore and stroke: 88·9 × 114·3mm (3·50 × 4·50in)
Number of cylinders: 6 in line, straight vertical, water cooled, petrol-driven inlet over exhaust valve engine
Compression ratio: 6·4 to 1
Maximum hp (gross): 129bhp at 3750rev/min (governed)
Maximum torque (gross): 29kgf m (209lbf ft) at 2500rev/min
Coolant capacity: 20·4 litres (4½gal)
Oil capacity: 12·5 litres (2¾gal)
Lubrication: dry sump system

Transmission
Clutch: Daimler fluid coupling
Gearbox: Daimler driver-controlled, pre-selective epicyclic unit providing five speeds
Transfer box: forward and reverse gear trains having spiral bevel directional control gears with positive dog engagement and a double helical drop-down gear to a single central bevel-type differential which, in combination with the gearbox, provides five forward and five reverse gears
Gear box ratios: top 1·000:1; 4th 1·568:1; 3rd 2·437:1; 2nd 4·381:1; 1st 6·046:1
Transfer box ratio: 1·347:1
Bevel box ratio: 1·923:1
Hub reduction ratio: 3·5:1
Overall ratios: top 9·08:1; 4th 14·24:1; 3rd 22·13:1; 2nd 39·78:1; 1st 54·90:1
Steering: three-track 15·87mm (⅝in) pitch recirculating ball servo system on front wheels
Tyres: 11·00 × 20 run flat high-speed non-directional cross-country type. 12·00 × 20 desert tyres can be fitted if requested
Brakes: Lockheed disc on all wheels, servo hydraulic foot-operated and hand-operated mechanical linkage attached to band brakes operated from front bevel box input shafts

Electrical system
Power supply: 24V (two 12V, 60Ah batteries)
Generators: two-speed (automatic) generator, 25A output at 600rev/min
Wireless supply: 24V
Instrument panel: (mph) km/h type panel can be fitted if requested

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Daimler Road, Radford, Coventry, England
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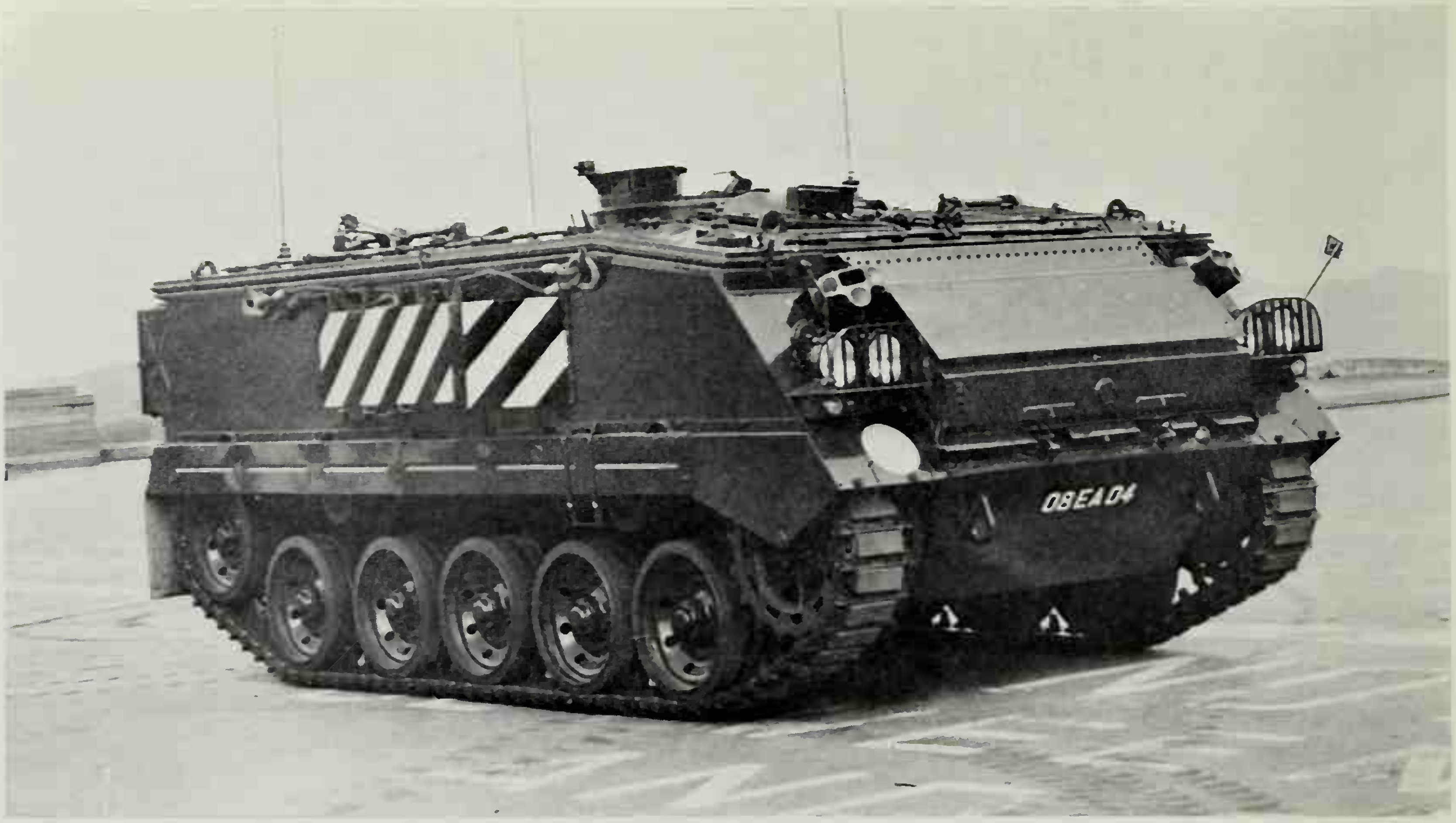
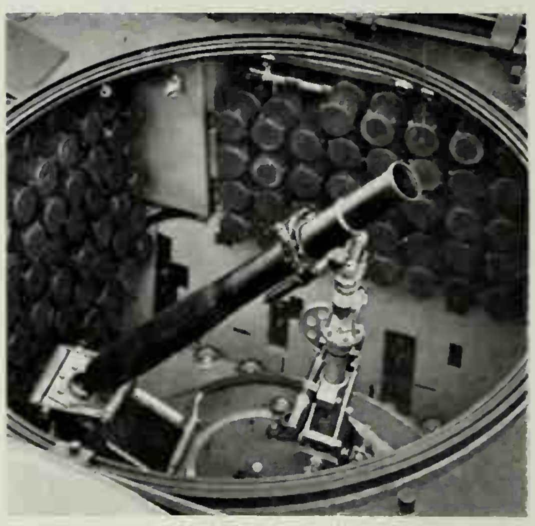


Anti-tank
The vehicle is designed to carry the Wombat infantry anti-tank recoilless gun with 14 rounds of ammunition. In this role the FV432 can carry three men plus driver and commander

Mortar
In this role, the vehicle is fitted with the 81 mm mortar. A large hatch in the roof permits a 360 traverse. Ammunition racks which can carry 134 rounds are designed for easy access. Four men plus driver and commander can be carried

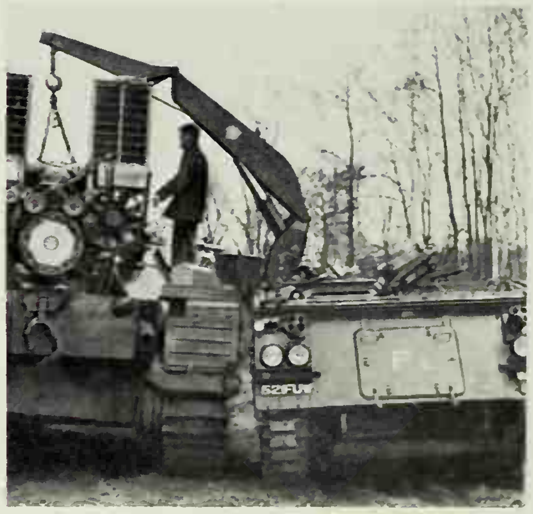


Command
In the command role, the vehicle is fitted with two map frames and a series of fold-away tables. It is already wired for additional radio equipment. It can accommodate five men plus driver and commander

Ambulance
The FV432 can carry 4 stretchers, which are easily loaded and unloaded, plus additional medical equipment

Cargo
The FV432 has an exceptionally large capacity and can carry a payload of approximately 3630 kg (8000 lb). Quick loading and unloading is possible through the rear door and top hatch

FV434
Another member of the family, the FV434, has been developed to carry out repairs in the field to all types of armoured vehicles. It is equipped with an hydraulic crane to assist with the removal and replacement of heavy units



Armoured vehicle

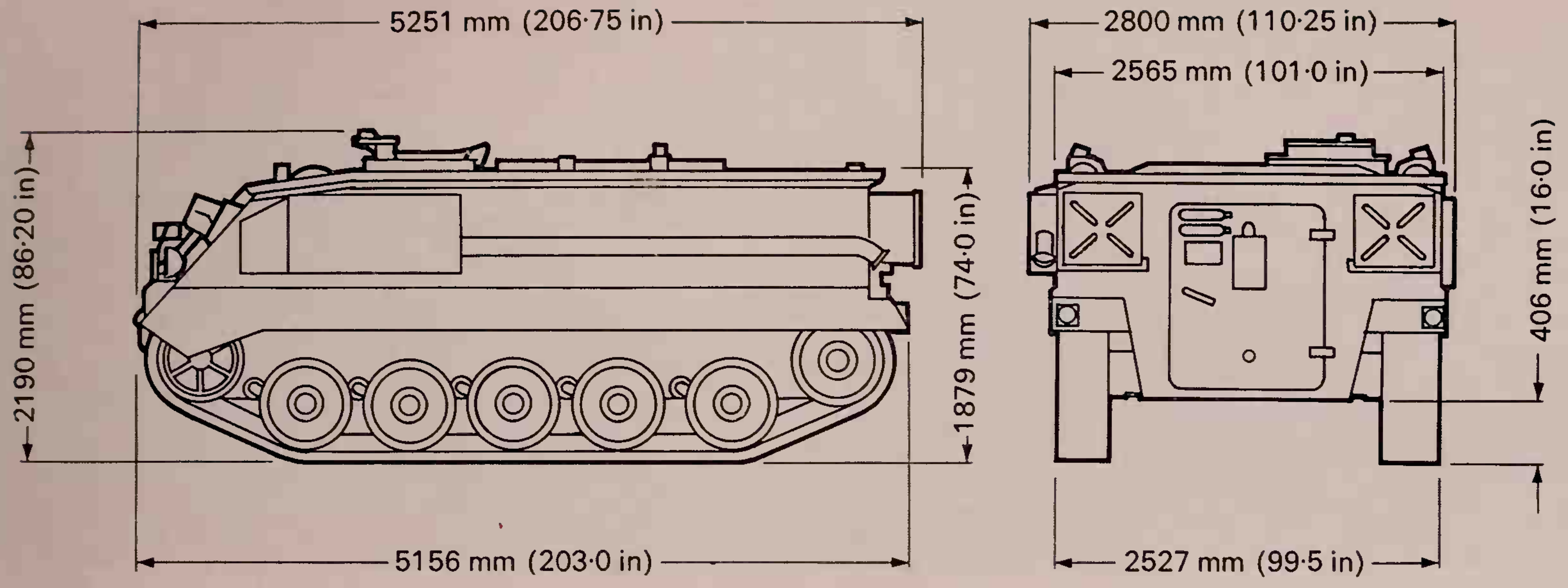
for personnel carrying and other duties

The FV432 is a versatile amphibious vehicle providing armoured protection to infantry detachments. Its basic role is the transport of up to ten infantrymen in full battle order, plus commander and driver.

A great deal of research and experience has gone in to its development with particular emphasis on comfort, seating, leg-room, ventilation, suspension, etc, under all conceivable conditions including nuclear warfare, where it becomes essential for the infantry to be administratively self-supporting for long periods.

The FV432 can go almost anywhere. It has an exceptionally good cross-country performance. It can wade (or shallow ford) depths of over 1 m (3 ft 6 in) or clear vertical obstacles 0·610 m (2 ft) high and negotiate gradients of up to 35° comfortably. It has a road speed of 51·5 km/h (32 mph) and a water speed of 6·5–7·4 km/h (3½–4 knots).

Its range of action is in the region of 580 km (360 road miles). In its troop-carring role the FV432 can be fitted with a turret mounting a 30 mm cannon which provides the vehicle with a kill-capability against enemy light armoured vehicles. Apart from its basic role of troop transportation, the FV432 can be adapted to six other roles of anti-tank, command, cargo, mortar, ambulance and recovery vehicles, being appropriately fitted for each role.



Specification

Dimensions
Length (overall): 5·251 m (17 ft 3 in)
Length (hull only): 4·826 m (15 ft 10 in)
Width (overall): 2·80 m (9 ft 2 in)
Width (over tracks): 2·527 m (8 ft 3½ in)
Length of track on ground: 2·819 m (9 ft 3 in)
Track centres: 2·184 m (7 ft 2 in)
Height to roof: 1·879 m (6 ft 2 in)
Height over machine gun: 2·286 m (7 ft 6 in)
Ground clearance: 0·406 m (1 ft 4 in)

Mobility
Maximum road speed: 52 km/h (32·5 mph)
Vertical obstacle: 0·609 m (2 ft)
Maximum gradient: 35°
Shallow fording: 1·066 m (3 ft 6 in)

Weights
Weight laden: 15 104 kg (33 300 lb)
Weight unladen: 13 607 kg (30 000 lb)
Weight airportable: 11 820 kg (22 000 lb)
Power/weight ratio: 11·29:15·25 kW/tonne (16·15 bhp/ton)
Fuel capacity: 454 litres (100 Imp gal)
Crew: 2
Personnel: 10 infantrymen

Engine
Type: K60 Mk 4F two-stroke, multi-fuel compression ignition, opposed piston
Fuel: diesel, gas turbine, MT gasoline premium grade motor spirit or a mixture of these fuels
Capacity: 6·57 litres (400·92 in³)
Maximum bhp (gross): 240 at 3750 rev/min
Maximum torque: 52·38 kgf m (379 lbf ft) at 2500 rev/min

Transmission
Gearbox: GM-Allison TX200-4A automatic with six forward gears and one reverse, with a torque coverter operating in 1st, 3rd and reverse
Steering: controlled differential unit

Tracks
Type: manganese steel, rubber-bushed and padded
Width: 343 mm (13½ in)
Pitch: 116·6 mm (4·59 in)
Links: 182
Ground pressure: 0·780 kg/cm² (11·11 lb/in²)

Suspension
Shock absorbers: on front and rear stations
Type: torsion bar—five road units per side; front sprocket drive with rear idler
Wheels: Five 609 mm (24 in) diameter rubber tyres double wheels per side

Communications
Various radio installations will be provided to suit the role in which the vehicle is to be used, but a common three-set harness is used for all tyres of installation

GKN SANKEY LIMITED
Automotive and Manufacturing Division
Hadley Castle Works, Wellington, Shropshire, England
Telephone: Wellington 4321 Telex: 35248

Shorland

armoured patrol car

Shorts' Shorland Mk2 and Mk3 armoured patrol cars are low-cost vehicles for border patrol, reconnaissance, convoy escort, mobile police and internal security duties. Each carries a crew of three: driver, commander and turret gunner. They are built on the 109in wheel-base Land Rover military chassis, with heavy-duty axles and suspension. The four-wheel drive has ratios for good cross-country performance and high speed on highways.

The Shorland is offered with the choice of two power units: the Land Rover four-cylinder petrol engine for operators who wish to standardise on this engine and the six-cylinder petrol engine for those requiring additional power to meet particularly exacting terrain conditions.

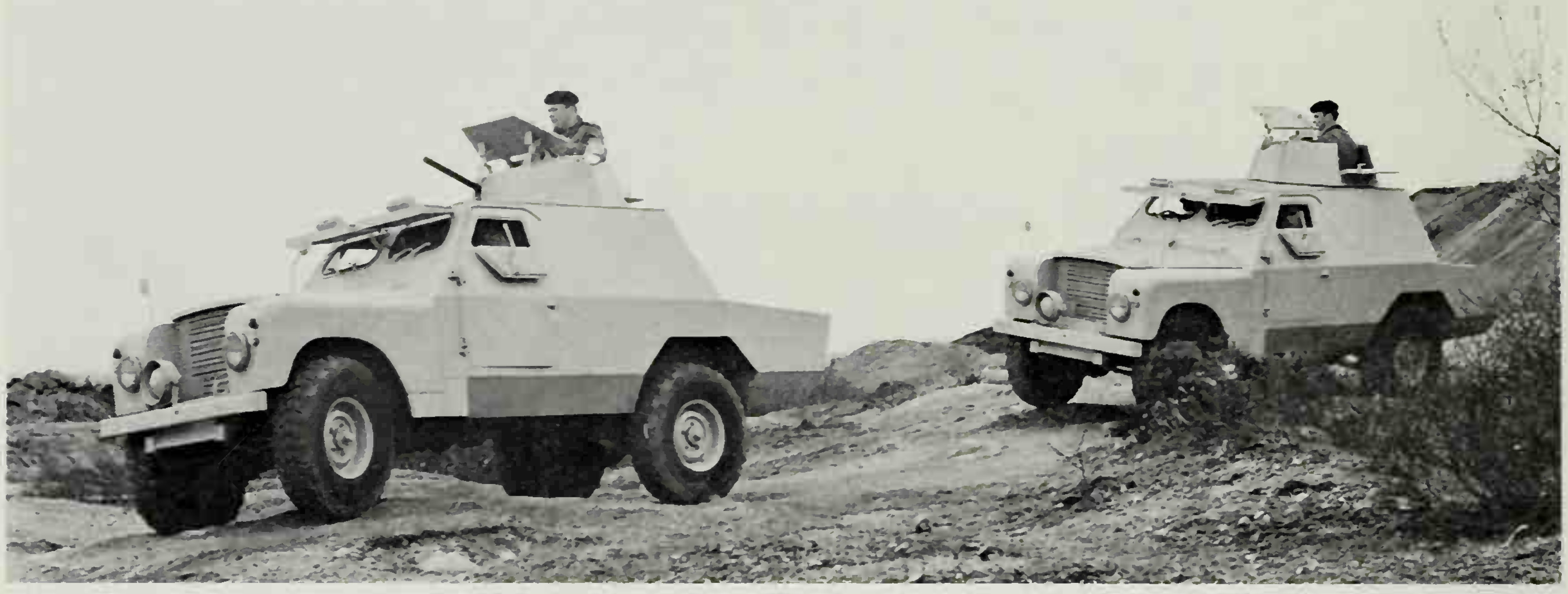
The armoured body provides the best possible protection, within the weight of the vehicle, against modern small-arms ball ammunition for crew, engine and fuel tanks.

The windscreens for driver and commander have protective drop-down visors and excellent visibility. Observation and escape hatches are provided in the turret and at the rear.

The manually operated turret can be continuously rotated through 360 degrees and can incorporate either a ·300 Browning or 7·62 GP machine gun with optical periscope sighting. Smoke discharger and tear gas projectors can also be fitted.

The vehicle is suited to use in hot or cold climates, having its interior insulated with polyurethane foam faced with tough plastic sheeting. A fresh-air heater/ventilation system is provided. Additional high-capacity air-extraction equipment is fitted as standard, making the vehicle suitable for operation in all climates.

Heavy-duty 9·00 × 16 dual-purpose tyres are fitted as standard, providing good traction for both cross-country and road running. Alternative sand tyres can be fitted for desert operations and run-flat tyres are offered for exceptionally arduous conditions.



Specification

Wheelbase: 2·77 m (109 in)
Track: 1·36 m (53½ in)
Overall length: 4·6 m (181 in)
Overall width: 1·78 m (70 in) including fittings
Overall height: 2·29 m (90 in)
Turning circle: 17·75 m (58 ft 3 in)
Fuel capacity: 64 litres (14 gal); with long-range tank 128 litres (28 gal)
Engine: Rover petrol
Chassis: Land Rover 109 in frame with improved departure angle
Gears: eight forward, two reverse using transfer box
Electrical equipment: 12 V negative earth 57 Ah battery
Brakes: Land Rover 28 cm (11 in) dia with servos
Suspension: heavy-duty semi-elliptical leaf springs with Aeon spring assistors and telescopic shock absorbers
Tyres: 9·00 × 16
Steering (RH or LH): recirculating ball, worm and nut; variable ratio, from 15·6 : 1 straight ahead to 23·8 : 1 on full lock

Four-cylinder engine (Mk 2)
Weight: kerb weight 2931 kg (6450 lb); operational weight including crew 3360 kg (three at 180 lb 7400 lb)
Engine size: 2286 cm^3 (139·5 in^3)
No. of cylinders: 4
Gross bhp: 77 bhp at 4250 rev/min
Maximum torque: 17 mkg (124 lb ft) at 2500 rev/min
Max. speed (average): road 80·47 km/h (50 mph); cross-country 48·28 km/h (30 mph)
Range of action (at average operating speed): standard tank 322 km (200 miles); long-range tanks 644 km (400 miles)
Gross power/weight ratio: 23·33 bhp/ton
Max. tractive effort in low gear: 460 kg (1011 lb) per ton
Max. climbing ability: 1 in 1·9
Max. gradient for stop and restart: 1 in 1·9

Six-cylinder engine (Mk 3)
Weight: kerb weight 2931 kg (6450 lb); operational weight including crew 3360 kg (three at 180 lb 7400 lb)
Engine size: 2625 cm^3 (160·3 in^3)
No. of cylinders: 6
Gross bhp: 95 bhp at 4500 rev/min
Maximum torque: 18·5 mkg (134 lb ft) at 1750 rev/min
Max. speed (average): road 88·4 km/h (55 mph); cross-country 48·28 km/h (30 mph)
Range of action (at average operating speed): standard tank 257·2 km (160 miles); long-range tanks 514·4 km (320 miles)
Gross power/weight ratio: 28·75 bhp/ton
Max. tractive effort in low gear: 540 kg (1172 lb) per ton
Max. climbing ability: 1 in 1·7
Max. gradient for stop and restart: 1 in 1·7

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General Engineering Division
Glen Works, Newtownards, Northern Ireland
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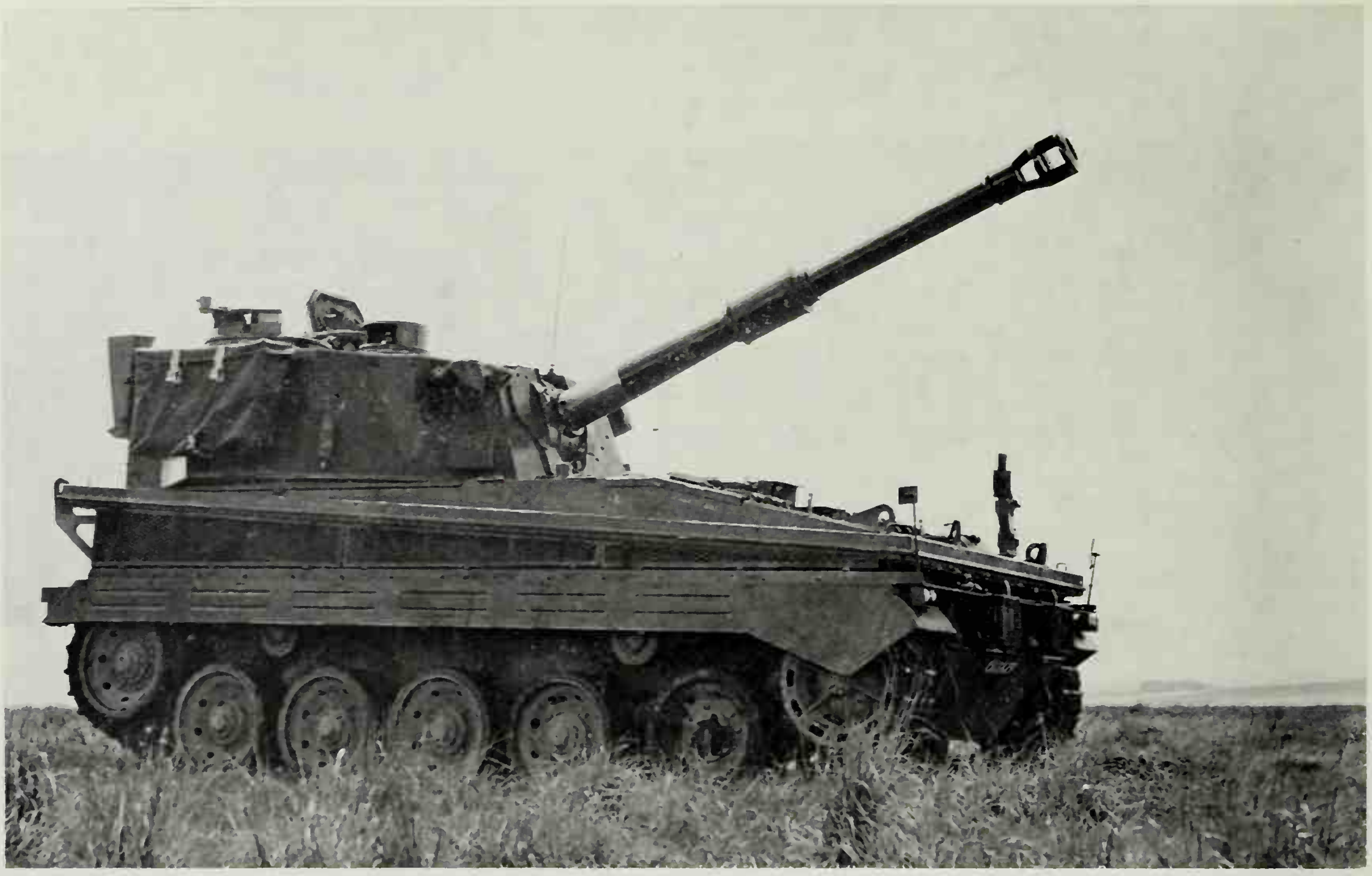
SHORTS

1967
1968
1969
1970

Section 9

Weapons and ammunition



Specification

Crew: 4 men

Dimensions
Laden weight: 15 900 kg (35 000 lb)
Overall length (gun forward): 5·72 m (18 ft 9 in)
Overall height (top of cupola): 2·49 m (8 ft 2 in)
Overall width: 2·64 m (8 ft 8 in)

Armament
Gun: 105 mm
  Elevation: max 70°
  Depression: max 5°
Rate of fire: 10 rounds per minute
Gun range: 17 000 m (18 000 yd)

Ammunition stowage: 36 rounds

Optional equipment
Commander's machine gun 7·62 mm (0·30 in) pintle-mounted

Engine: Rolls-Royce K60 Mk 60G 218 bhp SAE
Speed, max: 48 km/h (30 mph)
Operating range (approx): 390 km (240 road miles)

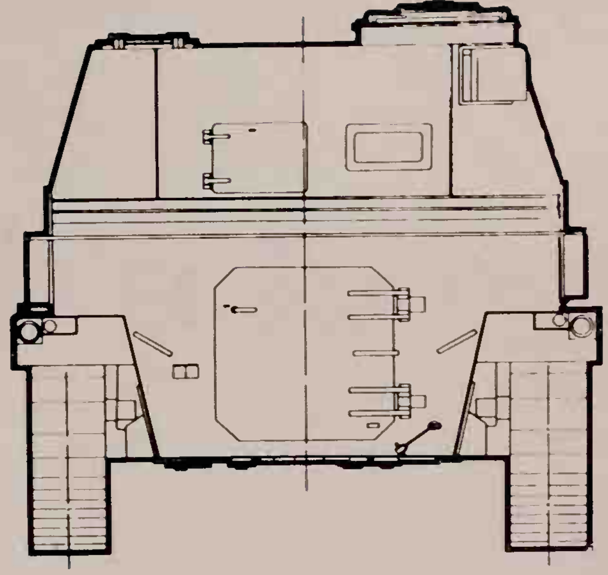
Amphibious capability
Wading depth (without preparation): 1·12 m (3 ft 8 in)
Water crossing (optional equipment): swimming with built-in nylon screen using track propulsion

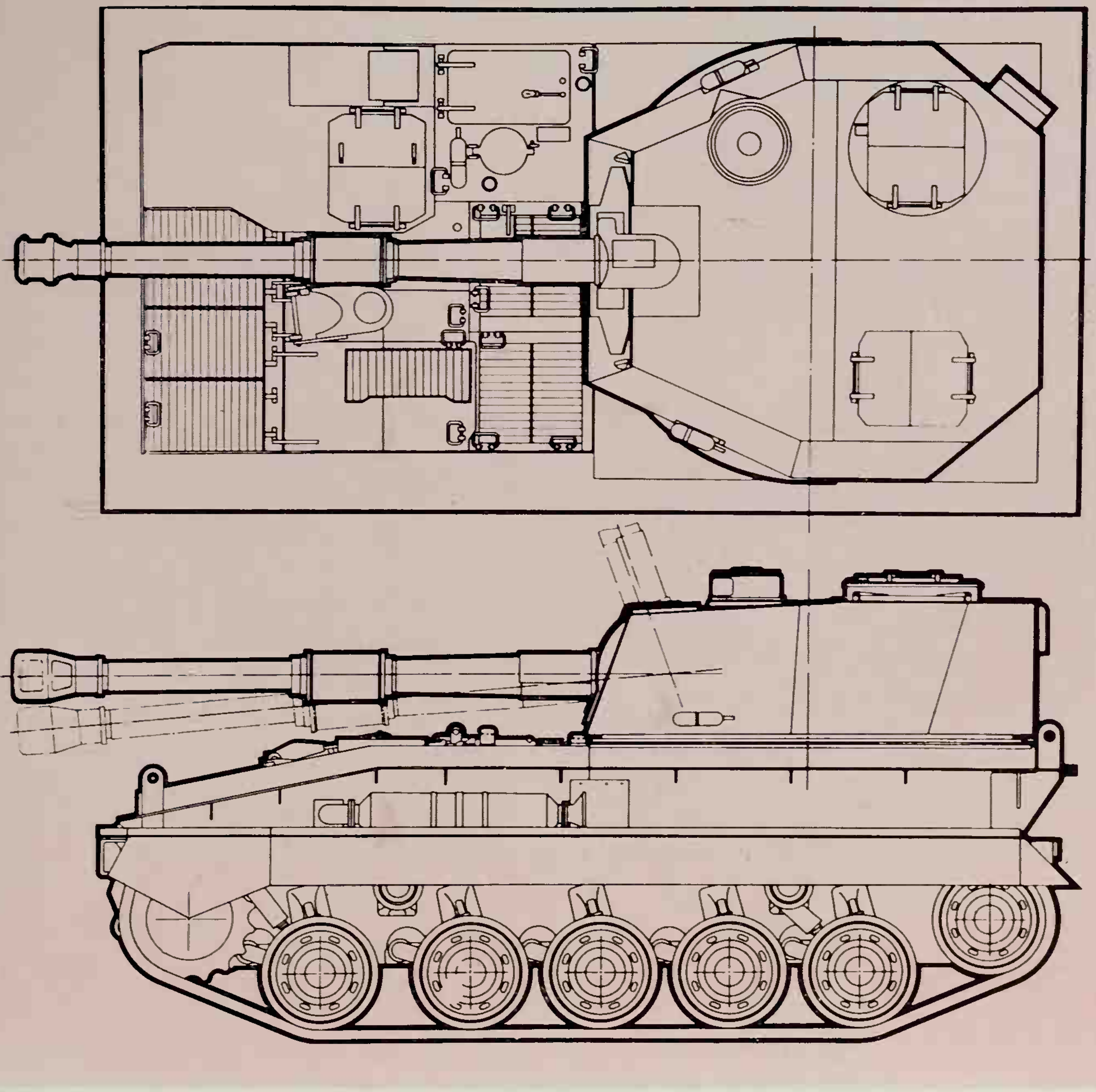
Abbot

105 mm self-propelled field gun

The Abbot is a tracked armoured vehicle with a turret mounting a 105 mm field gun. The turret has all-round traverse.

The armour provides the crew with protection against shell splinters, mines and small-arms fire. A Rolls-Royce K60 engine and semi-automatic transmission are provided. Abbot constitutes a highly mobile, amphibious, self-propelled field gun of great range and flexibility.





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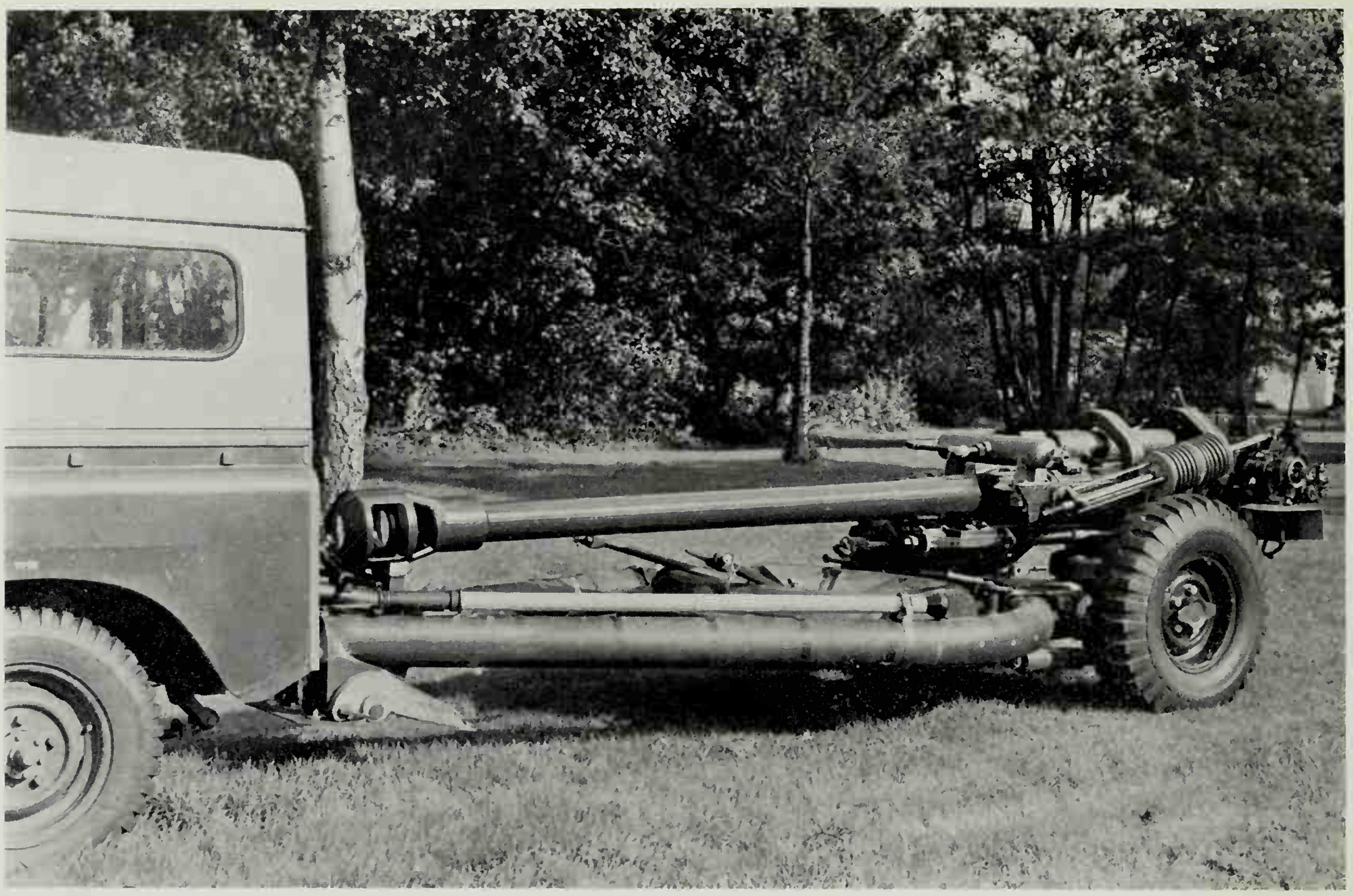
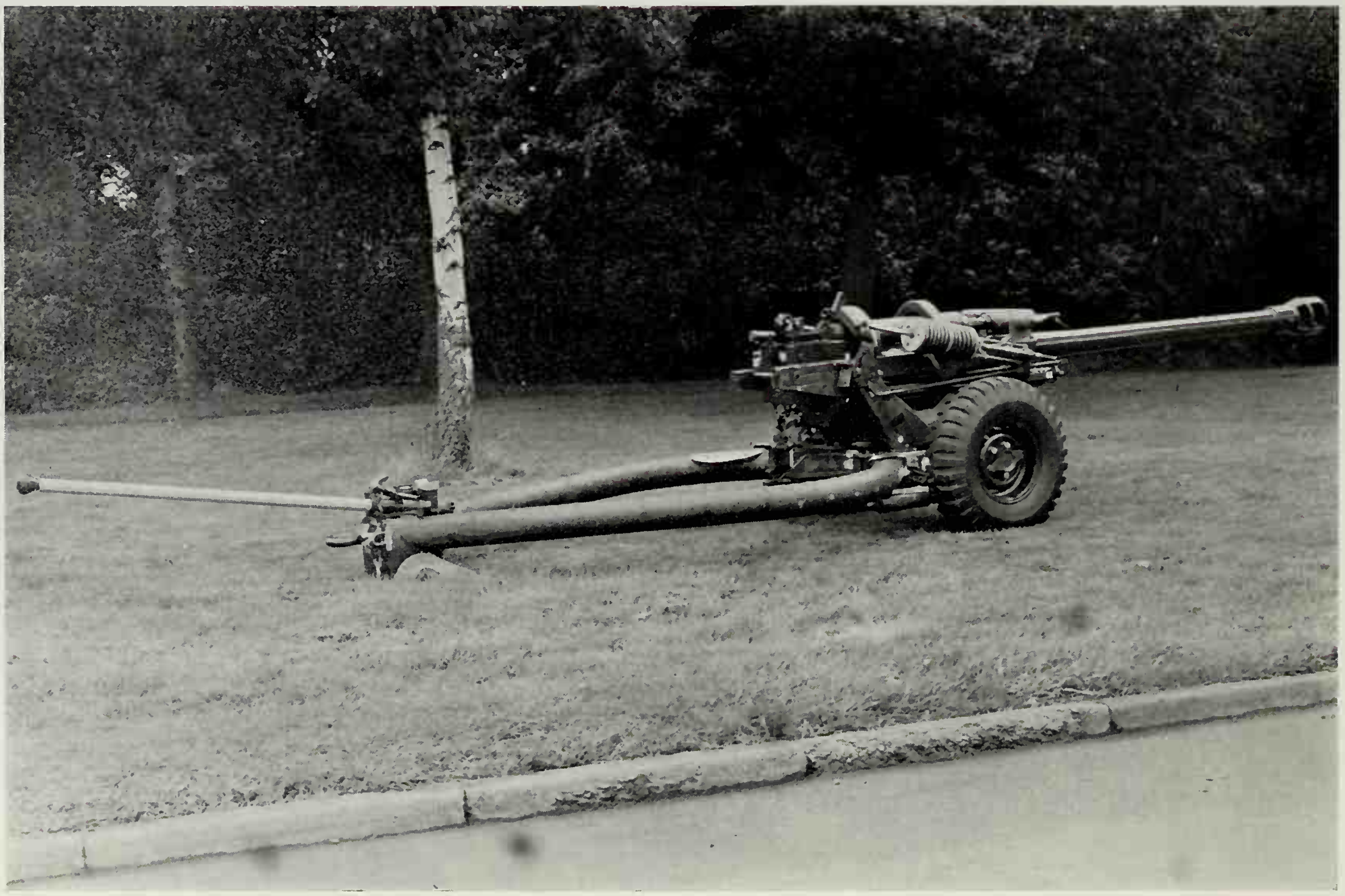
Vickers



This is the normal folded towing attitude, which provides a short robust equipment for towing cross-country and a compact size for air transport. It is achieved by jacking up the equipment (jack stowed on the trail), removing the quick-release wheel and traverse gear pin, swinging the gun through 180deg, clamping the barrel to the trail and finally replacing the wheel. The complete conversion takes less than one minute

To convert from the firing position to this towing attitude, the two links are removed, the equipment pushed forward off the platform which is then secured to the inside of the trail and the links re-fitted for travelling. This can be completed within one minute



105 mm light gun

close support weapon

The range, mobility and fire power of this advanced light and robust equipment makes it ideal for use in tough limited war conditions anywhere from the Arctic to the tropics.

A lethal punch is provided by the well-tried Abbot Mk 2 ammunition system. This includes a whole family of projectiles backed by a flexible multiple charge system which achieves ranges from 2500 to 15 000m.

The weapon has two towing attitudes. For high speed, long distance, rugged terrain, aircraft and helicopter portage the folded attitude is recommended.

The elevating mass can be removed to give two light helicopter loads. The weapon can be reassembled with simple tools in less than 30min.

The low silhouette and fast all-round traverse of this versatile gun help to give it an effective anti-tank performance with its HESH (high-explosive, squash-head) shell.

This lightweight high-performance towed gun has been designed using the latest computer techniques.

If required, the equipment can be linked into a fire control computer system, such as British FACE, which is described elsewhere in this volume.

Specification

Details	**Metric**	**English**
Range—maximum	15·1km	9·38 miles
minimum	2·5 km	1·55 miles
Total estimated weight	1588kg	3500lb
Comprising—elevating mass	939kg	2070lb
lower carriage and essential stores	649kg	1430lb
Rate of fire—maximum	6rev/min	6rev/min
sustained	2rev/min	2rev/min
Overall length—firing (0° quadrant elevation)	7m	23ft
Overall length—travelling (folded position)	4·8m	15ft 9in
Overall length—travelling (with gun forward)	6·8m	22ft 6in
Overall height—travelling (folded position)	1·22m	4ft
Overall height—travelling (with gun forward)	2·13m	7ft
Overall width	1·78m	5ft 10in
Track width	1·42m	4ft 7½in
Quadrant elevation—maximum	1250mils	70°
Quadrant elevation—minimum	–100mils	–5·5°
On carriage traverse (fine)	±100mils	±5·5°
Coarse traverse on platform	6400mils	360°
Recoil length—at 0° quadrant elevation	1·02m	45in
Recoil length—at 70° quadrant elevation	0·5m	20in
Loading angle	All elevations	All elevations
Tyres	9·00 × 16–6 ply	9·00 × 16–6 ply
Downward load on towing eye	79·4kg	175lb

Ammunition—UK Abbot Mk 2 complete system up to Charge 5; or US 105mm including M1 type by using special ordnance. UK Abbot Mk 1 complete system using US M1 shell.

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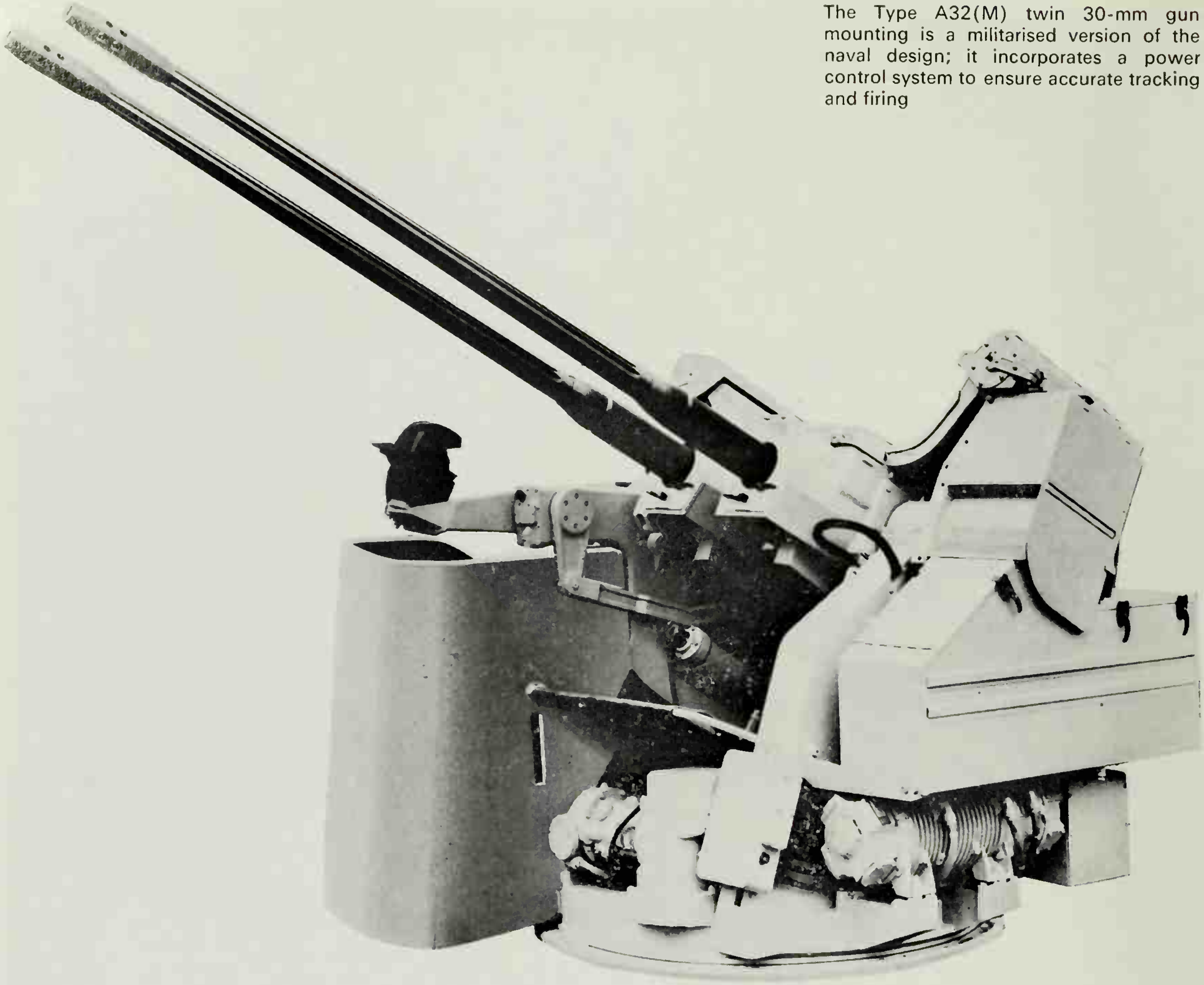
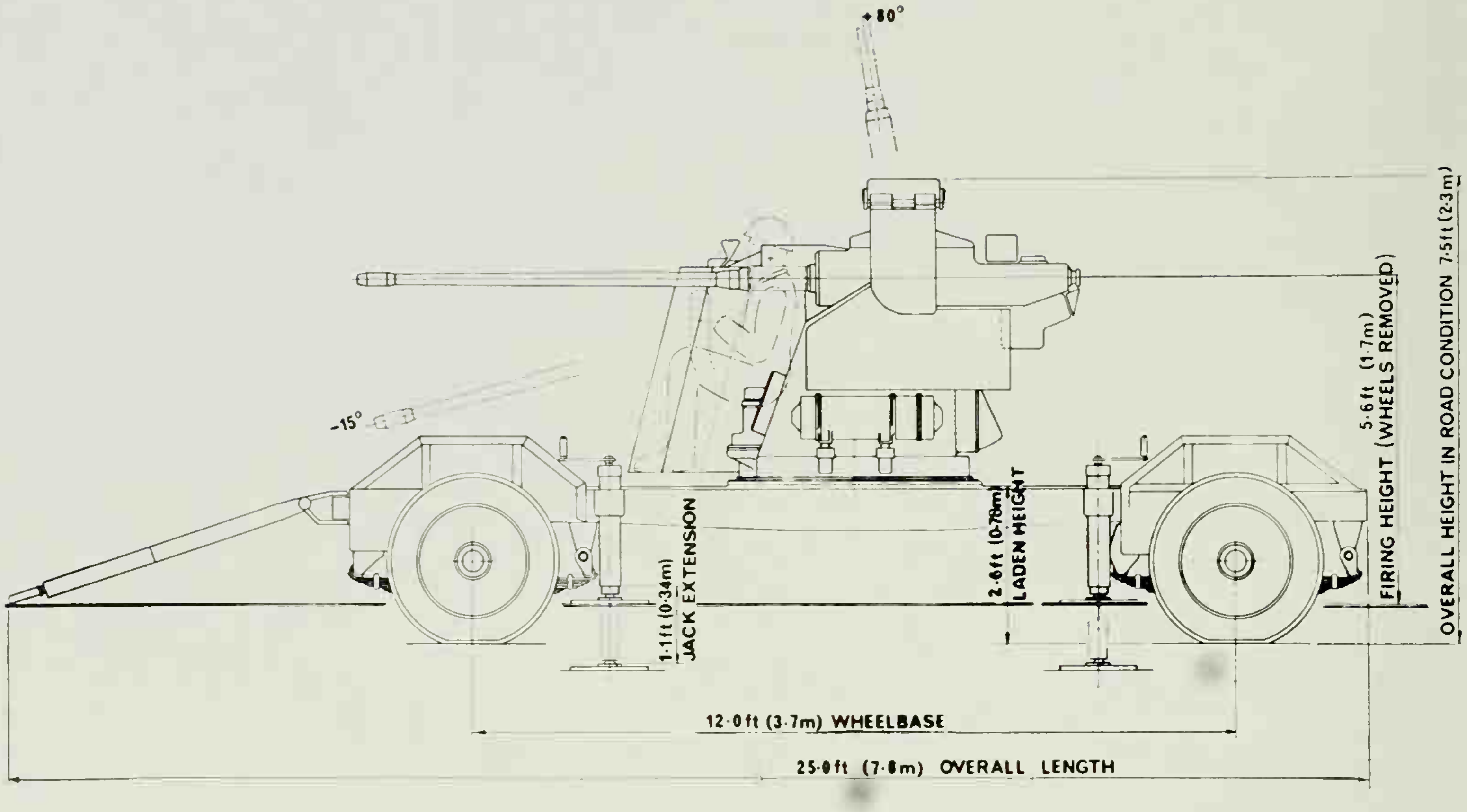
Director of Sales (Army)
St Christopher House, Southwark Street, London SE1, England
Telephone: 01-928 7999



The Type A32(M) twin 30-mm gun mounting is a militarised version of the naval design; it incorporates a power control system to ensure accurate tracking and firing


+80°
-15°
1·1ft (0·34m) JACK EXTENSION
2·0ft (0·70m) LADEN HEIGHT
5·6ft (1·7m) FIRING HEIGHT (WHEELS REMOVED)
OVERALL HEIGHT IN ROAD CONDITION 7·5ft (2·3m)
12·0ft (3·7m) WHEELBASE
25·0ft (7·8m) OVERALL LENGTH

The Type A32(M) gun mounting is intended for mobile as well as static roles. It is shown here mounted on a modified FV2505D trailer. For rapid stationary action the jacks are lowered. For maximum accuracy from a remote controller, the road wheels are removed, allowing a lower firing height to be achieved

Anti-aircraft gun

Gyro-stabilised twin 30-mm military gun mounting

The Type A 32(M) AA weapon system offers lightweight and effective mobile defence of mobile columns, airfields and other static targets against attack by low-flying aircraft and tactical missiles.

Local protection of the gunner is provided by the use of a fully armoured shield, and working voltages can be modified to suit customers' specific requirements. This mounting is a development from the highly successful naval mounting Type A32, a complete specification of which can be found elsewhere in this Catalogue.

Static target defence

The high rate of fire of the two 30 mm HSS weapons and the highly lethal damage of a single hit, coupled with the accuracy of aiming the weapons, ensures that the Type A32(M) mounting is an effective AA defence system.

For clear visibility use it can be used under local control with or without early warning from a surveillance radar. For night use or in poor visibility it is possible to connect it to a radar director for complete remote control.

Mobile column defence

The Type A32(M) mounting can be installed on a trailer for free transportation. The weapons can be used immediately the system is stationary and power is supplied, but for more precise operation from a remote director, the road wheels are removed to allow a lower firing height for increased stability.

Due to the fact that the Type A32(M) system is fully gyro-stabilised it can be used with good accuracy when on the move if fitted to a tracked armoured personnel carrier. Many standard military trailers or armoured personnel carriers can be modified to accept the A32(M) concept.

Ammunition

The flexibility and the multiple characteristic of the A32 mounting are further enhanced by the availability of an extensive range of ammunition. HS 831L ammunition is designed specifically for the Hispano Suiza 30 mm cannon but has also been selected by the British Ministry of Defence as the basis of Rarden gun design, described elsewhere in this Catalogue.

Practice

Two types are available:
HE-P—An inert practice shell with the same ballistic properties as a live shell.
HET-P—An inert shell with tracer.

High-explosive

Both types of HE shell are filled with Trinalite, a patented explosive manufactured exclusively by Hispano Suiza.
HEI—HE incendiary shell with high blast effect (HS = UIA).
HEIT—HE incendiary shell with high blast effect and tracer (HS = UIAT).

Armour piercing

Two standard shells are provisioned:
APICT—Armour-piercing incendiary with hard metal core and tracer (HS = RINT).
APHEI—Armour-piercing incendiary with self-destruction base fuze (HS = RIA).

As a guide, the APICT projectile perforates 30 mm of armour at 50° relative to the horizontal at a range of 1000 m (1094 yd).

Fuzes

A mechanical nose fuze is fitted to HEI and HEIT shells. This is designed to function on impact but also embodies a means of self-destruction after a pre-determined distance of travel. Inherent in the design are features to ensure absolute safety in storage handling and transportation. A delayed arming device ensures a muzzle safety distance of about 10 metres and the fuze hammer is arranged to resist raindrop impact to the equivalent of striking cardboard of 0·5 mm thickness. Fuze sensitivity is in direct relationship to the speed of shell rotation so that it becomes more sensitive as the shell approaches self-destruction.

APHEI ammunition incorporates a mechanical base fuze embodying all the relevant features, including self-destruction, of the nose fuze.

In addition to the ammunition described above, we also produce a range of other types of ammunition in 20 and 30 mm calibres; details of these are given elsewhere in this Catalogue and full particulars are available from British Manufacture and Research Company Limited on request.

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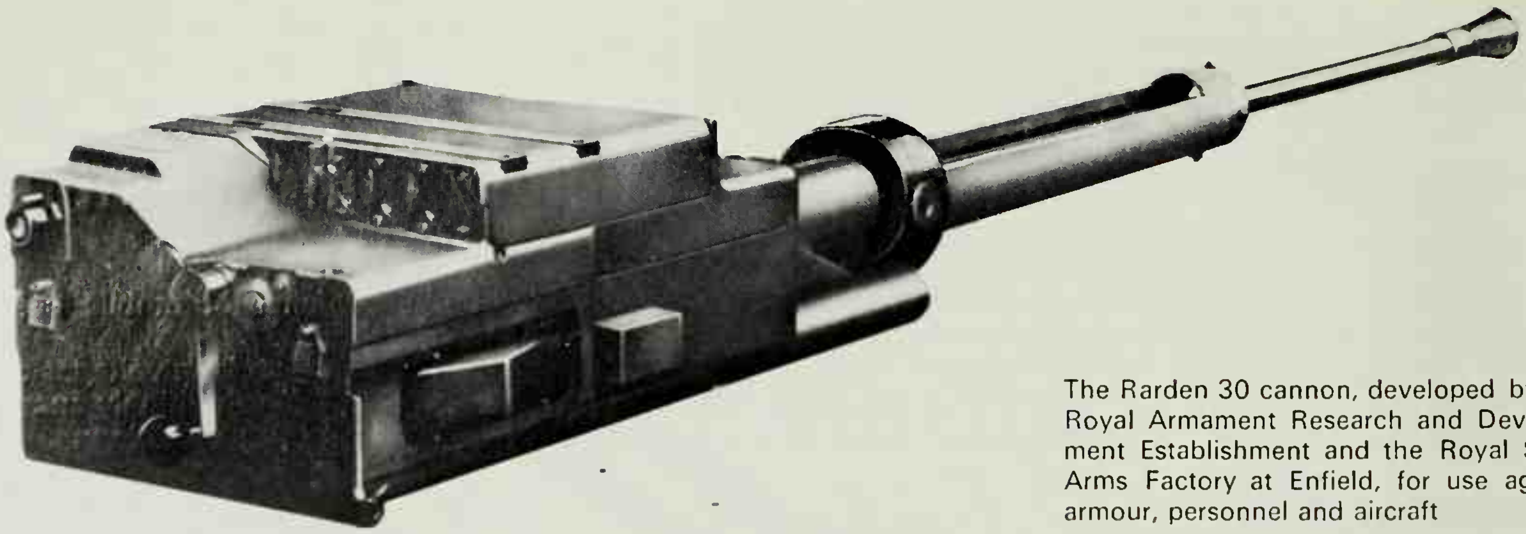
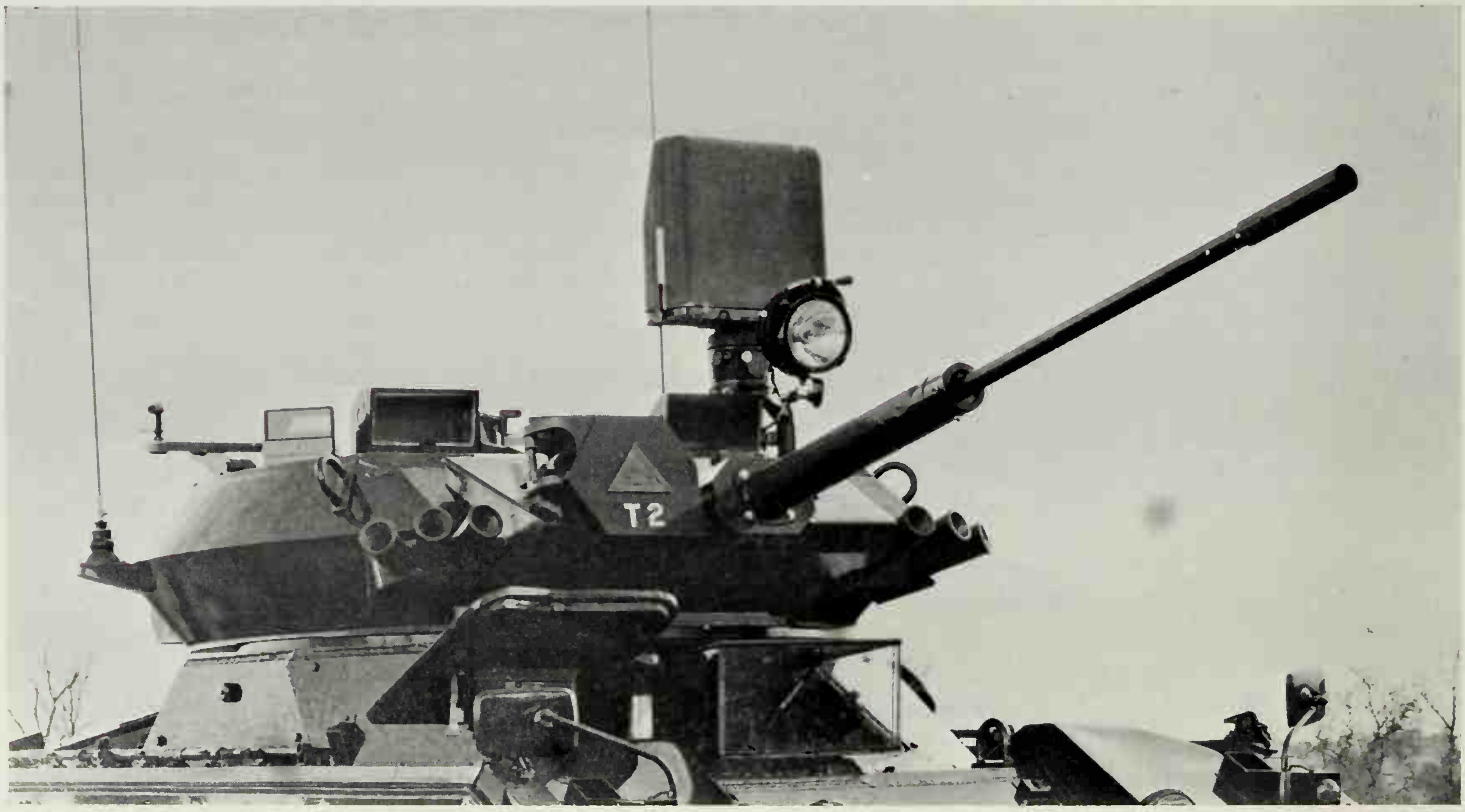


The Rarden 30 cannon, developed by the Royal Armament Research and Development Establishment and the Royal Small Arms Factory at Enfield, for use against armour, personnel and aircraft

Overall length	280 cm (9 ft 9 in) of which only 23 cm (9 in) need be inboard. This simplifies mounting and allows ample room in the turret
Weight	100 kg (220 lb), comparable with 20 mm Hispano (75 kg) and 20 mm Oerlikon (96 kg). It weighs far less than the 30 mm Hispano HS831 (136 kg)
Long recoil	limiting trunnion loading to the low figure of 1360 kg (3000 lb)
Sliding breech block	as in tank guns, enabling length of the gun to be minimised
Operation	is normally single-shot aimed fire with automatic loading. Ammunition is supplied in clips of 3 rounds. The gun can hold two of these. Automatic fire at a rate of approximately 80–120 rounds per minute is possible for a burst of 6 rounds

The Rarden 30 cannon fitted in a typical armoured fighting vehicle with two-man turret



Rarden 30

automatic cannon

The Rarden 30 cannon is primarily a compact single-shot self-loading weapon, but is also capable of firing automatically at a rate of approximately 80–100 rounds per minute. The full load is 6 rounds, 5 in the feed way and 1 in the chamber. Two clips of three rounds fully load the weapon. Careful assessment indicates that this is more than enough for a successful engagement of typical light armour targets. Additional rounds could not be used in the short span of an air engagement. The gun is normally loaded by the gunner. If a loader is available, continuous aimed fire is possible.

Hand cocking, by rotating a small handle, is required only at the start of action. The breech is held open on firing the last round and closed by pressing a catch after reloading the magazine.

The gun fires with the breech locked by operating an electric switch. Only the solenoid and firing hammer move, giving immediate response, with minimum disturbance of the lay of the gun. Mechanical firing is also available.

All recoil and other operations take place within a closed casing. The spent cartridge cases are ejected forward out of the turret, reducing toxicity hazards to the minimum and dispensing with the need for bulky ventilation machinery—an important feature when considering a weapon to operate from armoured vehicles in radioactive areas.

As the rounds are fed in from the rear, the gun need protrude only nine inches into the turret. Access to the feeding and breech mechanism is nevertheless excellent. The top part of the casing can be removed completely in seconds without tools, conveniently carrying with it all the feed mechanism for maintenance and inspection. The breech mechanism is then fully revealed and the recoil system can be examined. A jammed round can be cleared by lifting open the top and reaching inside the casing.

As the whole mechanism is enclosed, there is no difficulty in operating in dirty and wet conditions.

Ammunition

To achieve the outstanding performance of the Rarden 30 against armour an armour-piercing discarding sabot (APDS) round has been developed by the Royal Armament Research and Development Establishment.

For other roles standard Hispano Suiza 831 L ammunition is available. The gun was deliberately designed to take this existing family to ensure that quick development of the system was not delayed by any problems of ammunition development.

For the Rarden 30, although all HS 831 L rounds can be fired, tracered ammunition is considered essential, to enable the aim of each round to be corrected.

Range table ground-to-ground for Hispano rounds

Range, metres	Elevation, mils	Time of flight, sec	Residual velocity, m/sec
400	2·0	0·39	976
1000	5·5	1·08	820
2000	13·7	2·59	585
3000	27·4	4·70	394
4000	51·4	7·71	300

The maximum range, provided there is no self-destruction, is 10 200m

		Hispano		
	RARDE APDS*	High explosive UIAT	Armour piercing RINT	Practice ET
Weight of projectile, gram	290	360	360	360
Weight of HE filling, gram	—	28	—	—
Weight of cartridge case, gram	350	350	350	350
Weight of complete round, gram	780	870	872	870
Muzzle velocity m/sec	1200 +	1100	1080	1080

*Figures for APDS are approximate

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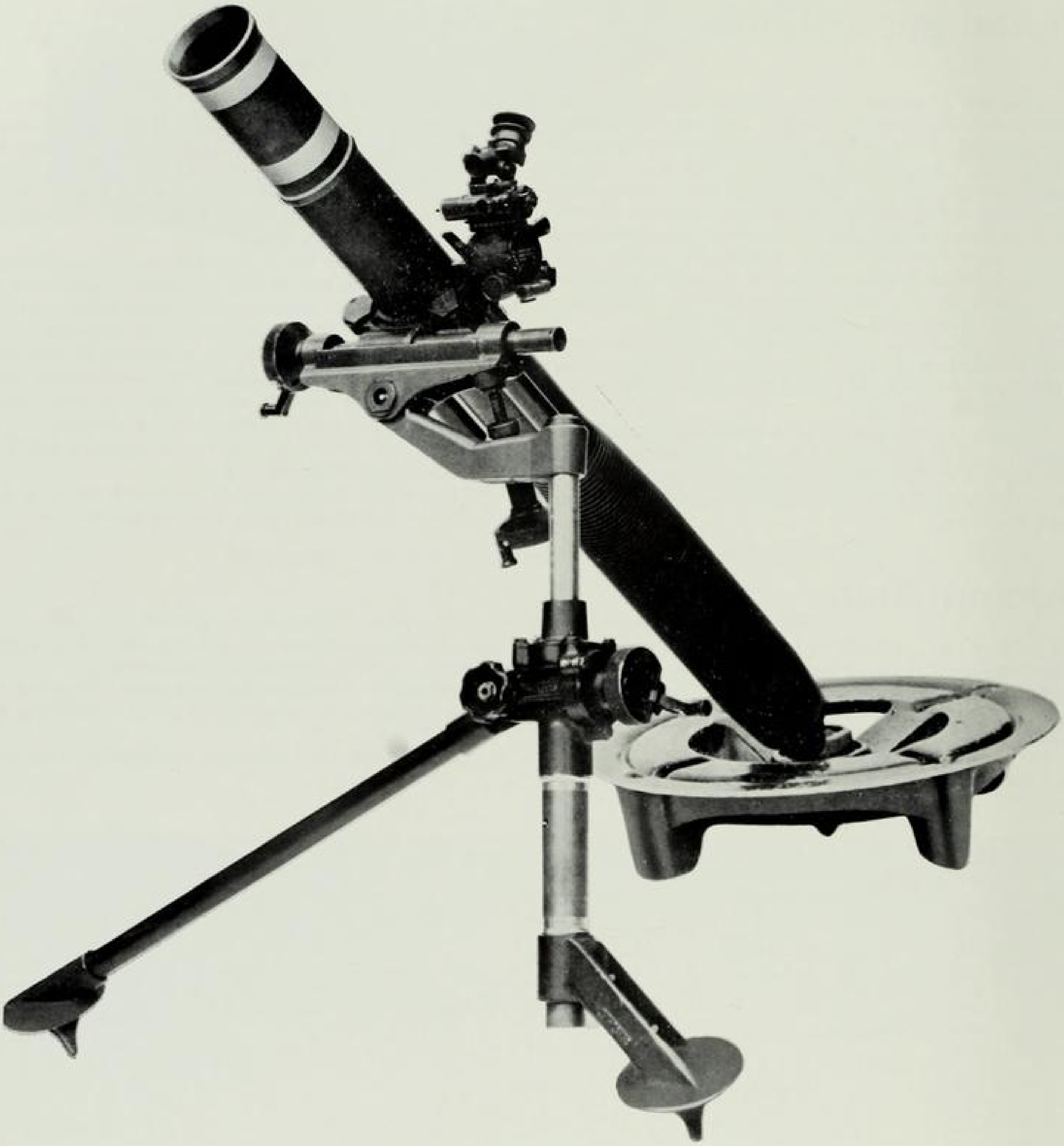

To stand up to the exacting conditions of battle and to provide a high sustained rate of fire, a mortar must be of great strength and capable of withstanding extreme heat. At the same time, it must be as light as possible to permit rapid movement to battle positions and easy portability in difficult terrain.

The new British mortar, shown above, has a barrel of high-strength steel with cooling fins to dissipate heat, so that it can withstand prolonged firing at maximum charge.

The bipod mounting is of special steel and light alloy construction for maximum strength combined with lightness. It is designed so that one man can lay the mortar, the elevating and traversing mechanisms being sealed for long life and low maintenance.

Vehicle mounting is possible.

The baseplate, forged in light alloy with four deep webs, gives good support, combining great strength with low weight.

The sight provides great accuracy.

The whole unit can be carried in three one-man loads, of which the heaviest is only 12·3kg (27lb).

Mortar system

81mm medium mortar

The new British 81mm mortar system provides unequalled performance together with operational and logistic economy. It is the only weapon system of its kind which offers exceptional range, great accuracy, maximum lethality, high sustained rate of fire, and great strength coupled with low weight.

Because of its exceptional range, it can very often carry out tasks which would otherwise require the use of field artillery. Because of its accuracy, far less ammunition is needed to deal with a given target.

The mortar and its ammunition are in general worldwide use by the British Army, and both have been thoroughly tried and tested on active service. The system has also been adopted by other armies throughout the world.

On these two pages the mortar itself is described; on the following pages its ammunition is dealt with.

Technical specification

Range

4500m (4900yd) with standard charge
5400m (5900yd) with special charge

Accuracy

0·5% probable error in range
1½mils in line

Rate of fire

15 rounds/min at 4500m (4900yd) indefinitely with standard UK ammunition
Slightly less with special charge giving greater range

Lethality

Over 40% of bomb body forms lethal-size fragments (many other types achieve little over 20%)

Weight and mobility

35·4kg (78lb) without sight
Three one-man loads, heaviest 12·3kg (27lb)

Barrel

Weight: 12·3kg (27lb)
Overall length: 127cm (50in)
Outside diameter: 8·6cm (3·4in) muzzle end
Outside diameter: 9·4cm (3·7in) breech end
Calibre: 81mm

Bipod mount

Weight: 11·8kg (26lb)
Overall length (folded): 114·3cm (45in)
Elevation range: 45–85 deg (800–1515 mils)
Traverse range: 100 mils left and right of zero at 45 deg (800 mils) elevation

Base plate

Weight: 11·4kg (25lb)
Overall diameter: 55·8cm (22in)
Socket size: 5·08cm (2in)

Sight unit C2

Weight: 1·25kg (2lb 12oz) sight only
Weight: 5·22kg (11lb 8oz) sight including case and illuminating apparatus

Mobile operation

Special mounting allows mortar to be fired from British armoured personnel carrier (FV432)

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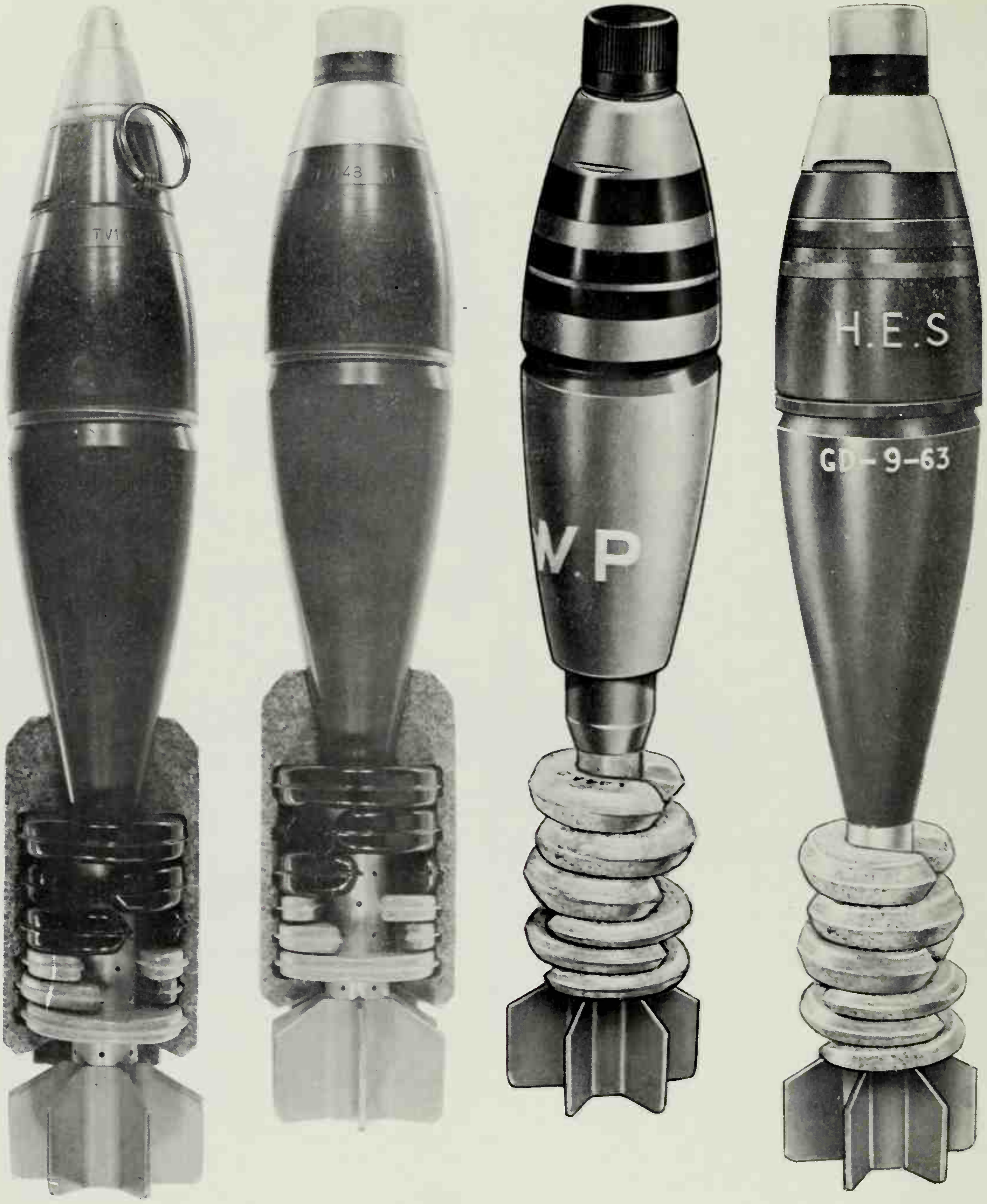
Director of Sales (Army)
St Christopher House, Southwark Street, London SE1, England
Telephone: 01-928 7999



Typical rounds of 81mm mortar ammunition: Left to right, round 81mm HE L15A4 fused L35; round 81mm HE L15A3 fused No 162; typical smoke round; and typical HE round

Mortar system

81mm medium mortar ammunition

Ammunition available for the 81mm mortar system includes high-explosive, smoke and practice rounds which have been specially designed to match the mortar and to achieve a general range of well over 5000m (5500yd) with great accuracy at all ranges.

The high-explosive bomb has a special cast-iron body which explodes into a large number of small fragments, each capable of causing lethal injury. Fragmentation into a few large pieces and ineffective metal dust, which occurs with many other types of mortar bombs, has been eliminated.

The short-ranging bomb (a well-known failing with other mortars which constitutes a hazard to the user's own troops) does not occur at all with this system.

Specification

High-explosive round
(Round, 81mm mortar, HE L15A3)

Weight: 4·4kg (9lb 13oz)
Filling: 60/40 (RDX/TNT)
Body: ductile cast-iron
Tail unit: extruded aluminium alloy
Fuse: No 162 or L35
Propellant in celluloid container: porous nitrocellulose NC30
No of augmenting charges: 6
Primary cartridge: filled cordite WM 017
Obturation: plastic ring
Overall length: 51·05cm (20·1in) with L35 fuse; 47·24cm (18·6in) with No 162 fuse
Range: minimum 200m (220yd)
Range: maximum well over 5000m (5500yd) with supercharge

Smoke round
(Round, 81mm mortar, Smoke WP L19A1)

Weight: 4·5kg (9lb 14oz)
Filling: white phosphorous
Body: grey cast-iron
Fuse: No 162 or L35
Overall length: 49·78cm (19·6in) with L35 fuse; 45·97cm (18·1in) with No 162 fuse

Practice round
(Bomb, 81mm mortar, practice L22A1)

This is a re-usable store item designed to fire with a maximum range of 80m (90yd) when the obturating ring is fitted. It is in service with the British Army

Ranges given by the existing six augmenting charge system:

	Minimum	Maximum
Primary	200m (220yd)	500m (550yd)
Charge 1	400m (440yd)	1000m (1100yd)
,, 2	600m (660yd)	1700m (1860yd)
,, 3	800m (880yd)	2200m (2400yd)
,, 4	1100m (1200yd)	3000m (3280yd)
,, 5	1400m (1530yd)	3700m (4050yd)
,, 6	1600m (1750yd)	4500m (4920yd)

A special extended-range charge gives a range of 5400m (5900yd)

Packaging

The ammunition is supplied in strong waterproof containers, each holding two rounds; two such containers are fitted into a steel box, resulting in a very robust package which, with four rounds, weighs 33kg (72lb)

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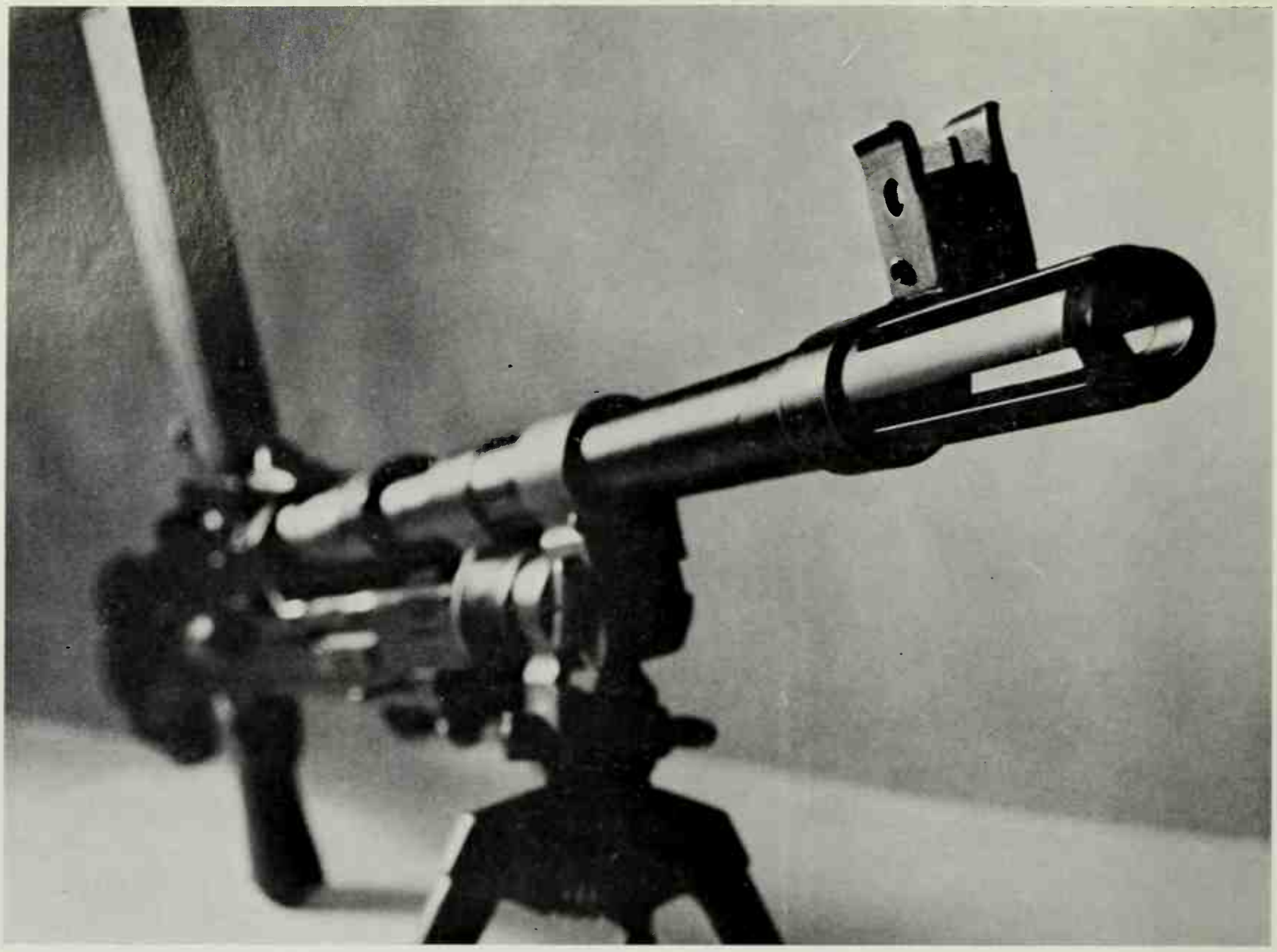
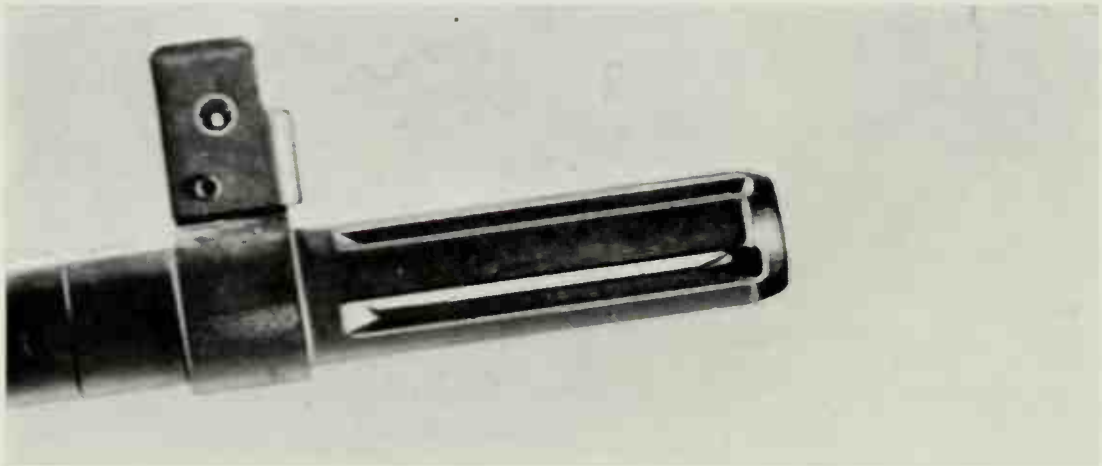


Bren conversion to NATO 7·62mm calibre ammunition

New lease of life for the Bren

The Bren gun has long been a deservedly popular weapon with the men in action the world over. By converting it to use modern NATO 7·62mm ammunition—now made possible by the Royal Small Arms team at Enfield—the many excellent features of this weapon have been given a valuable new lease of life and the overall flexibility of the gun has been greatly increased.



What the Enfield conversion comprises: At the Royal Small Arms Factory, Enfield, all marks of ·303in Bren light machine gun are converted to fire present-day ammunition. Conversion comprises the supply of several entirely new components, including barrel, magazine and breech-block assembly; also modification and machining of the body and other units, requiring special plant and tooling.

Important: All original parts retained in the converted Bren are carefully checked for wear or other defects and are renewed where necessary. Thus, every Enfield Bren conversion means delivery of virtually a brand-new gun.

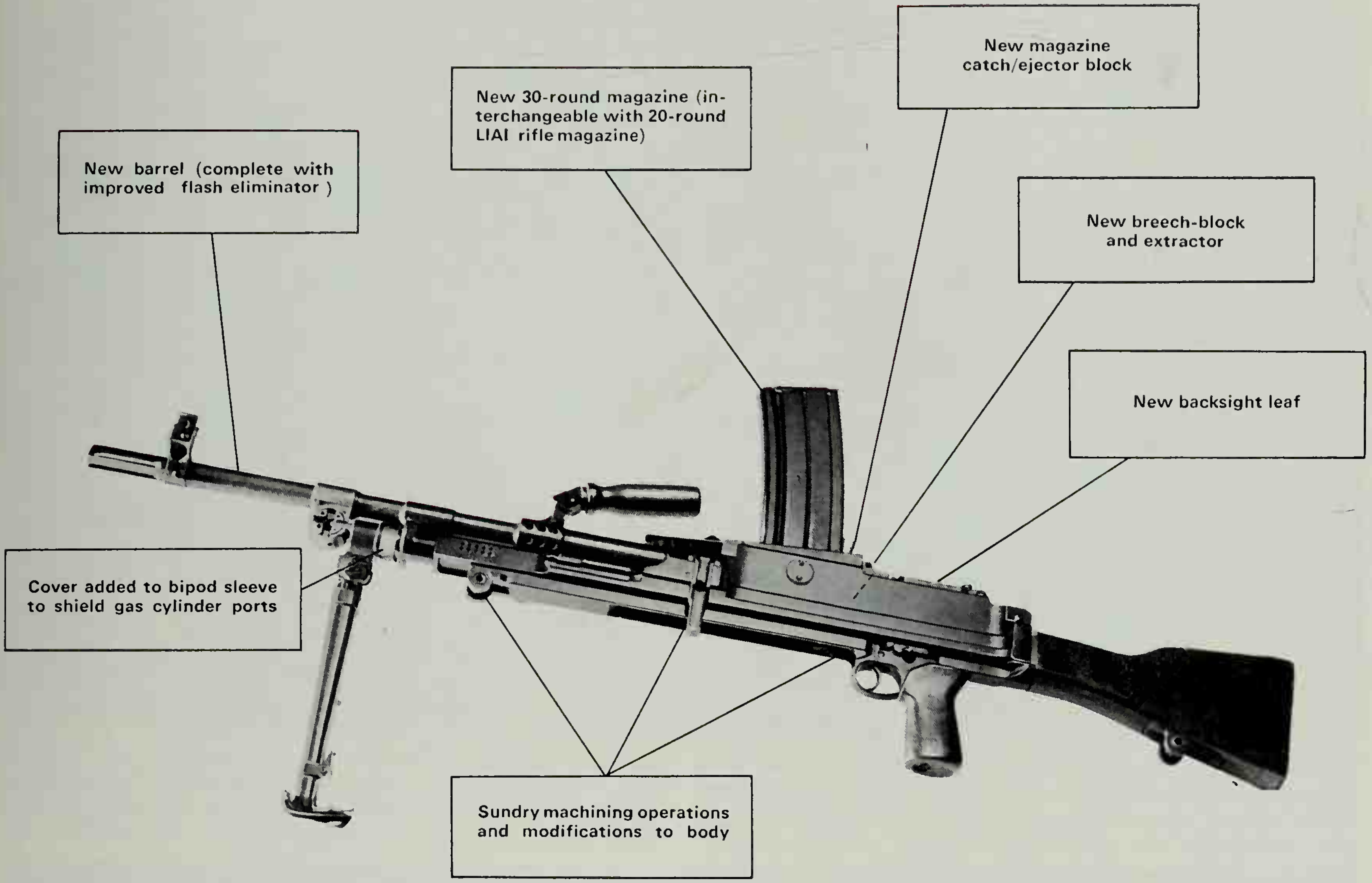
Improved flash eliminator—better barrel too: One of the features of the Enfield Bren conversion is the introduction of a much improved flash eliminator. Also a new barrel, chromium-plated in the chamber to give better operation under adverse conditions and in the bore for greatly prolonged barrel life.

Interchangeable magazines for greater flexibility: The new 30-round magazine has been specially designed to be interchangeable with the 20-round magazine of the LIAI rifle, which will give welcome flexibility in the field.

Further information and quotations: If you require more details about the Bren conversion, or firm quotations on price and delivery, please contact the Director of Sales (Army) at the Ministry of Defence in London.

Bren machine gun

conversion to NATO ammunition


New magazine catch/ejector block
New 30-round magazine (interchangeable with 20-round LIAI rifle magazine)
New barrel (complete with improved flash eliminator)
New breech-block and extractor
New backsight leaf
Cover added to bipod sleeve to shield gas cylinder ports
Sundry machining operations and modifications to body

Main features of RSAF Bren conversion

Specification

General particulars

Type of feed: magazine, 30 round
Position of feed: top, downward
Position of ejection: bottom, downward
System of operation: gas, four-position adjustment
Type of fire: single shot and automatic
Rate of fire: 500–575 rounds/min
Muzzle velocity: 869m/sec
Type of cooling: air, removable barrel
Type of cocking: hand, right-hand side, folding
Type of front sight: blade
Type of rear sight: leaf, graduated to 2000metres or yards
Bore diameter: 7·54 + 0·05mm
Rifling diameter: 7·798 + 0·10mm
Rifling width: 2·79 + 0·02mm
Number of rifling grooves: 6
Twist of rifling: 1 turn in 305mm right-hand
Shot travel: 0·5m
Chamber chromium-plated: 0·025mm thick minimum
Bore and rifling chromium-plated: 0·05mm thick minimum

Main dimensions

Overall length: 1237mm

Overall height
(magazine removed and bipod folded): 224mm

Overall height
(magazine fitted and bipod extended): 422–460mm

Overall width
(bipod folded): 114mm

Length of barrel assembly: 613mm

Length of magazine: 216mm

Weight of complete weapon
(less magazine): 9·52kg

Weight of magazine
(empty): 0·39kg

Weight of magazine
(full): 1·09kg

Weight of barrel assembly: 2·63kg

MINISTRY OF DEFENCE
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St Christopher House, Southwark Street, London SE1, England
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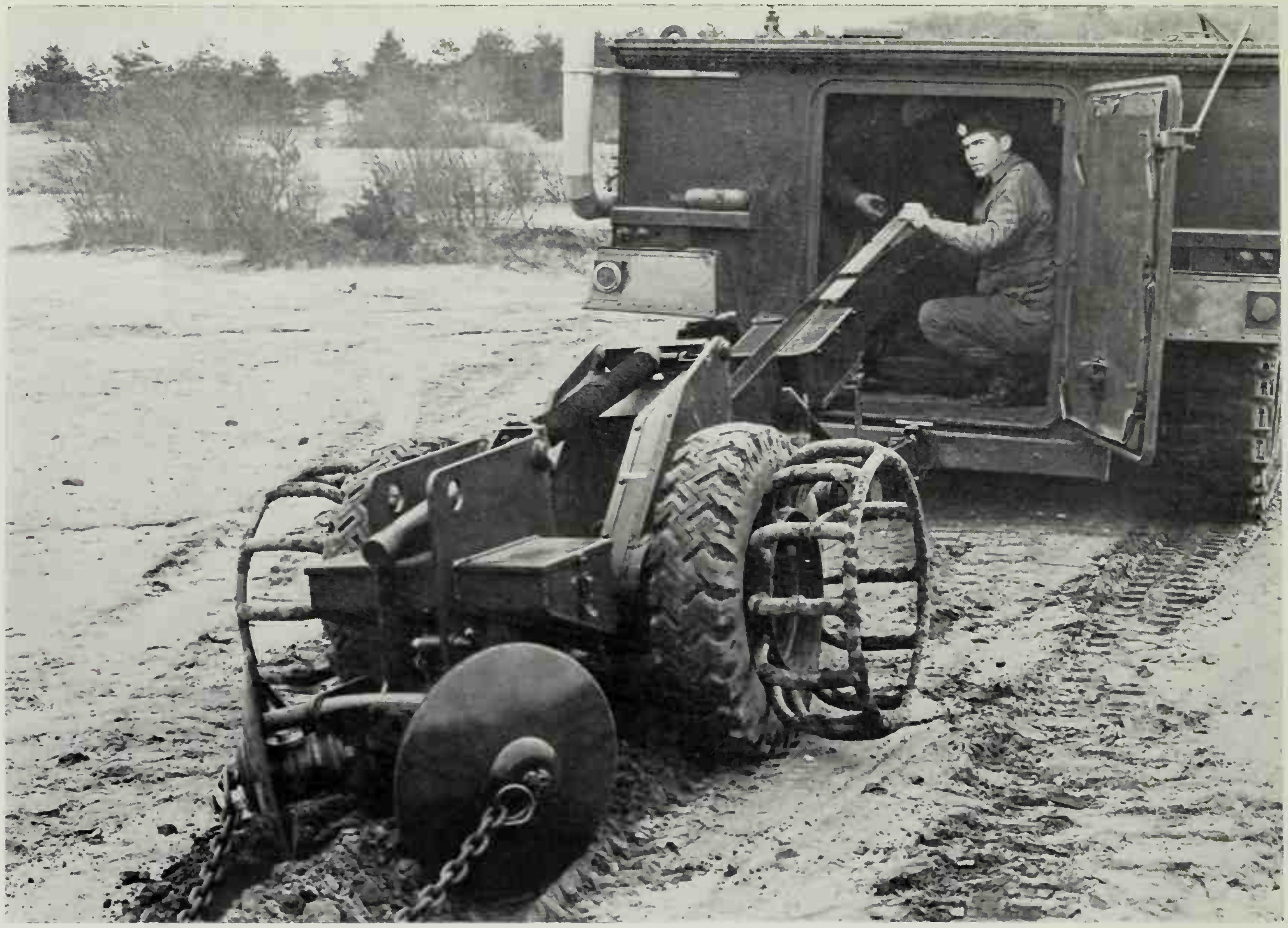
RSAF



The mine-laying plough, fitted with cage wheels, towed by a standard armoured personnel carrier. The harrow discs close the trench opened by the plough point after the mines are laid. The chain attached to the discs drags the surface smooth

Bar mines are loaded on to the conveyor of the plough from the safety of an armoured vehicle. Conveyor height is adjustable. Buried laying rate is 600–700 mines per hour. The plastics-cased mines cannot be located by electro-magnetic detectors

Bar mine system

Bar mines and mine-laying equipment

The new British bar mine system combines great effectiveness in inhibiting enemy movement with simplicity, safety and economy in the deployment of mines.

The system is based on the use of a new type of mine and of a mine-laying 'plough'. The mines are transported in and the plough is towed by any suitable vehicle, usually a tracked armoured personnel carrier.

Bar mine

The new bar mine has a tough plastics casing housing the explosive charge and the fuze, which contains only very few small metal parts. The mine cannot be detected by any current electro-magnetic mine detector.

Extensive trials have shown that this mine is completely effective against any tank track and causes severe damage to tank belly armour.

The fuze is fitted before operational use and is armed immediately prior to loading; the mine can thus be handled, transported and stored in safety.

Because of its shape, 72 bar mines are combined into a unit load of approximately one cubic metre volume and 1 tonne in weight, securely steel-strapped to a standard pallet for ease of handling. Such a load is ideally suited for handling by the Eager Beaver fork lift tractor shown below and fully described elsewhere in this Catalogue. Bar mines can also be assembled in manpacks of four mines each for use in situations where trucks cannot be used.

The logistics of mine-laying are therefore greatly simplified.

Mine-laying plough

The bar mines are laid by a trailer-type plough of purely mechanical design; neither hydraulic nor electrical equipment is involved in its operation.

A conveyor arm above the tow bar accepts bar mines loaded from the armoured towing vehicle, without exposing personnel to enemy fire. The conveyor is adjustable in height to adapt it to any towing vehicle. It feeds the mines to an adjustable spacing mechanism, which deposits them in a trench of adjustable depth made by the plough. Two harrow discs then close the trench; a dragged chain may be used to smooth the surface. The plough and harrow can also be raised to allow the mines to be laid on the surface.

All wearing parts, such as the plough point, are quickly and simply replaced. The machine can be used on any type of soil capable of being ploughed.

Cage wheels can be quickly fitted to the two hubs to provide extra stability on soft or uneven ground at high travelling speeds.

The plough is capable of laying buried mines at the rate of 600–700 mines per hour and at even higher rates on the surface.

Conveyor, tow bar and cage wheels can be quickly removed for transport. The equipment is fully air-portable.

Advantages

The new bar mine system has many advantages, the most important being:

Greater effectiveness—bar mines cannot be located by mine detectors and damage to enemy armour is severe.

Greater efficiency—fewer mines are required to inhibit a given area.

Greater safety—bar mines can be laid from an armoured vehicle.

Greater speed—up to 700 bar mines can be buried per hour.

Improved handling—compact unit loads can be safely air-lifted, quickly handled in the field.

Specifications

Bar mine
Overall length: 1200 mm
Overall width: 108 mm
Overall height: 81 mm
Total weight: 11 kg
Weight of explosive: 8·4 kg

Laying plough
Overall length: 4190 mm
Overall width, including cage wheels: 1600 mm
Overall height: 1270 mm
Weight, ready for use: 1240 kg

Unit load of 72 bar mines
Height: 840 mm
Length: 1220 mm
Width: 1020 mm
Weight, including pallet: 855 kg
Effective density (load/package ratio): 88 percent

Standard unit load of 72 bar mines on a steel-strapped pallet. The load is safe and can be air-dropped. Manpacks of four mines each can also be made up

MINISTRY OF DEFENCE
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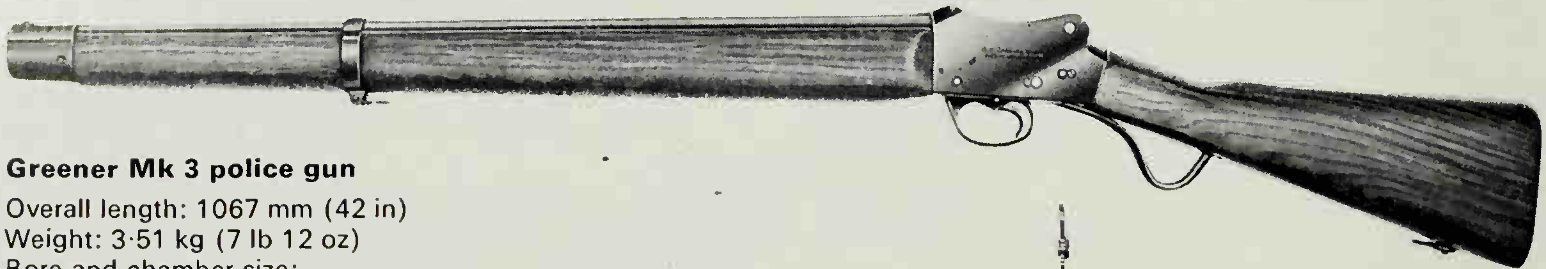
Anti-riot equipment

for short-range peace-keeping duties



Greener Mk 3 police gun

Overall length: 1067 mm (42 in)
Weight: 3·51 kg (7 lb 12 oz)
Bore and chamber size:
Mk 3/14: 73 mm (14/2⅞ in)
Mk 3: 73 mm (12/2⅞ in)
Mk 3/12: 70 mm (12/2¾ in)

Webley 1½-inch anti-riot gun

Barrel length: 246 mm ($9\frac{11}{16}$ in)
Overall length: 610 mm (24 in)
Weight: 2·48 kg (5½ lb)

Webley ·38 and ·32 Mk 4 revolvers

Pocket model
Barrel length: 76 mm (3 in)
Overall length: 178 mm (7 in)
Cylinder: six-shot
Weight: 0·67 kg (1 lb 7½ oz)

Webley ·38 Mk 4 revolver

Police and military model
Barrel length: 102 mm (4 in) or 127 mm (5 in)
Overall length: 254 mm (10 in) with longer barrel
Cylinder: six-shot
Weight: 0·76 kg (1 lb 11 oz)

The Greener Mk 3 police gun

This gun is intended for the dispersal of riots, guarding of vulnerable points, night ambushes, etc. It is constructed on semi-military lines to withstand the roughest usage, is a powerful and versatile short-range smooth-bore shotgun for use against targets at up to 100 metres, and has the Greener improved Martini action.

Three types are available to meet a wide variety of special needs. Mk 3/12 is chambered for use with standard 2¾ inch 12-bore cartridges obtainable all over the world. A special security feature is incorporated in the Mk 3 and Mk3/14 which fire only special ammunition. Cartridges may be loaded with any shot.

The Webley 1½-inch anti-riot gun

Typical uses for this gun are the dispersal of riots, the arrest of armed besieged criminals, etc. It is a short-range shoulder-controlled weapon for use by internal security forces. Accurate, robust, light in weight and simple to operate and maintain, this gun has a long barrel and adjustable rear sights for consistent accuracy over ranges of approximately 100 metres, firing standard 1½-inch tear gas cartridges. The gun is accurate to 300 × 300 mm at 40 metres. This gun can also be used for signal flares.

The Webley ·32 and ·38 calibre Mk 4 revolvers

These side arms are designed for close-quarter work and for personal defence. The break-open frame has a positive stirrup lock. When the top strap of the barrel is closed and the barrel catch is home, the breech fastenings form practically a solid mass. No force, short of one sufficient to tear the metal through the solid, could blow the pistol open. The hammer design prevents firing when the revolver is not securely fastened at the breech.

·38 calibre police and military model

The ·38 calibre police and military model is the latest and most efficient Webley revolver and embodies many new features. It offers power and accuracy with the ·38 S and W cartridge (145 grain bullet).

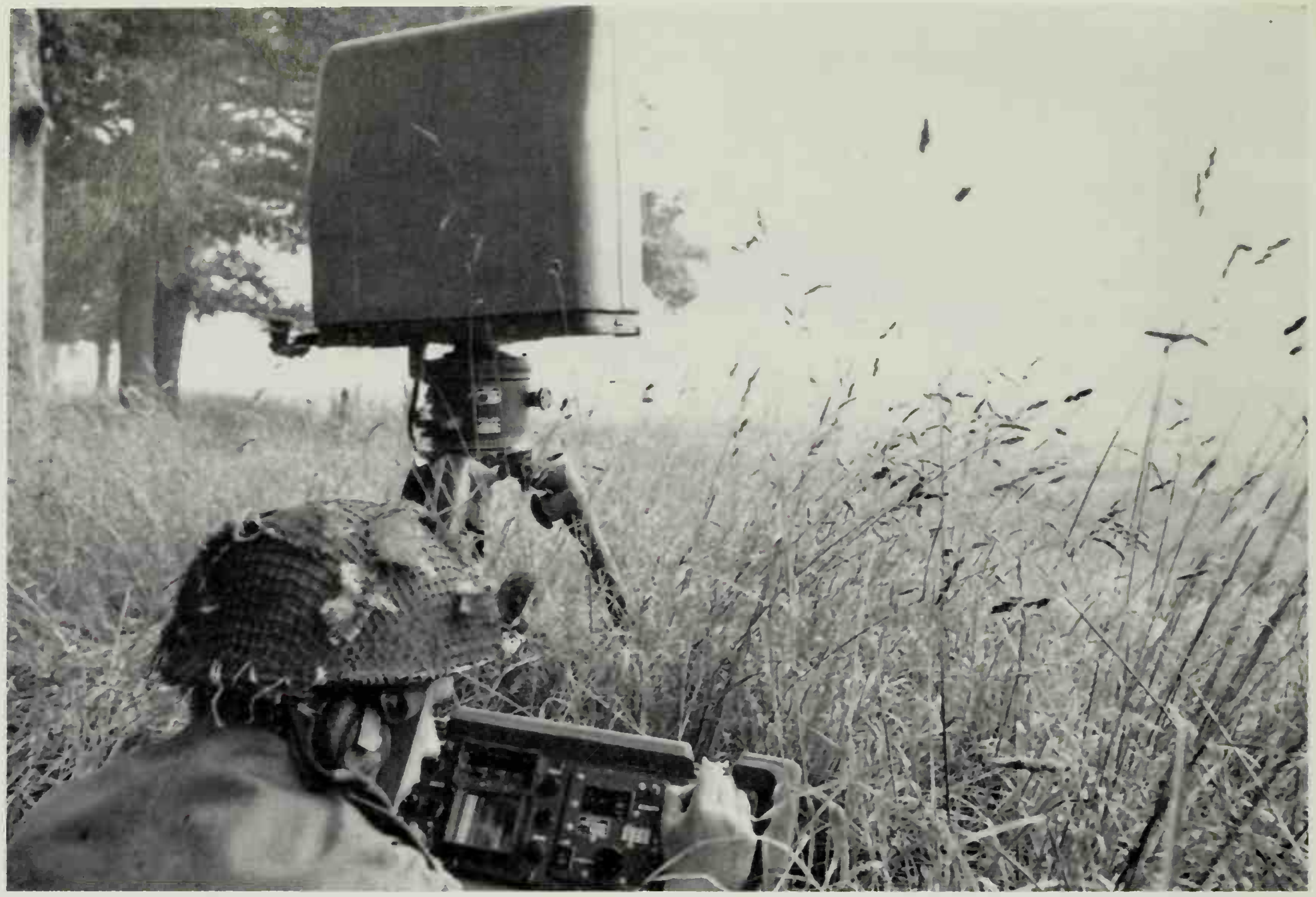
·38 and ·32 calibre pocket model

The ·38 and ·32 calibre pocket model has the same action and features as the police and military model but may be fitted with a small grip for handy pocket use or with a longer overhand pocket grip if required. A safety catch is included on this model.

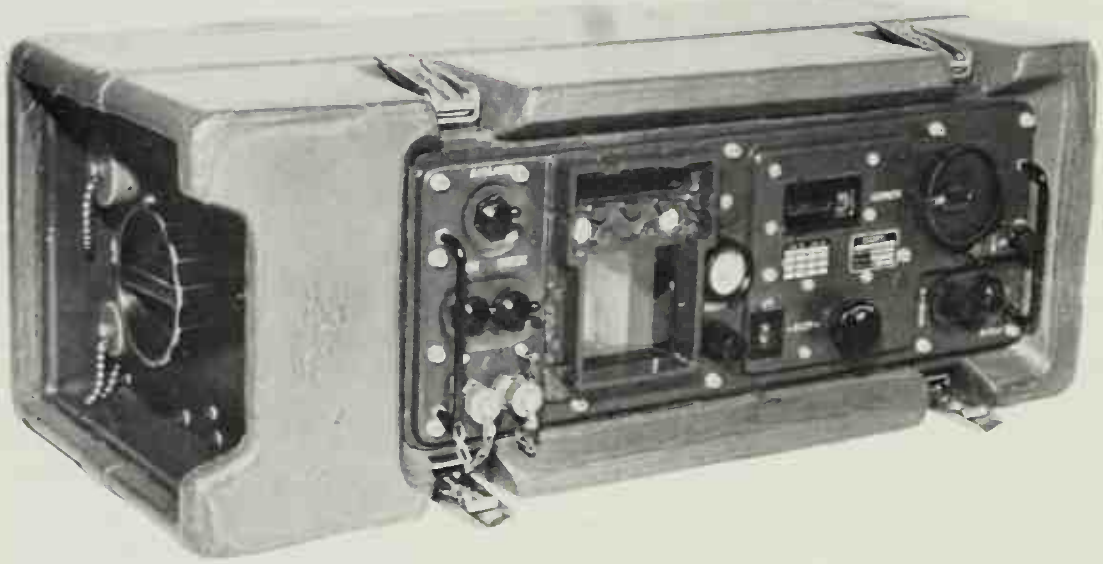
WEBLEY & SCOTT LIMITED
(incorporating W W Greener Ltd)
Handsworth, Birmingham 21, England
Telephone: 021-553 3952 Cables: Webley Birmingham

Section 10

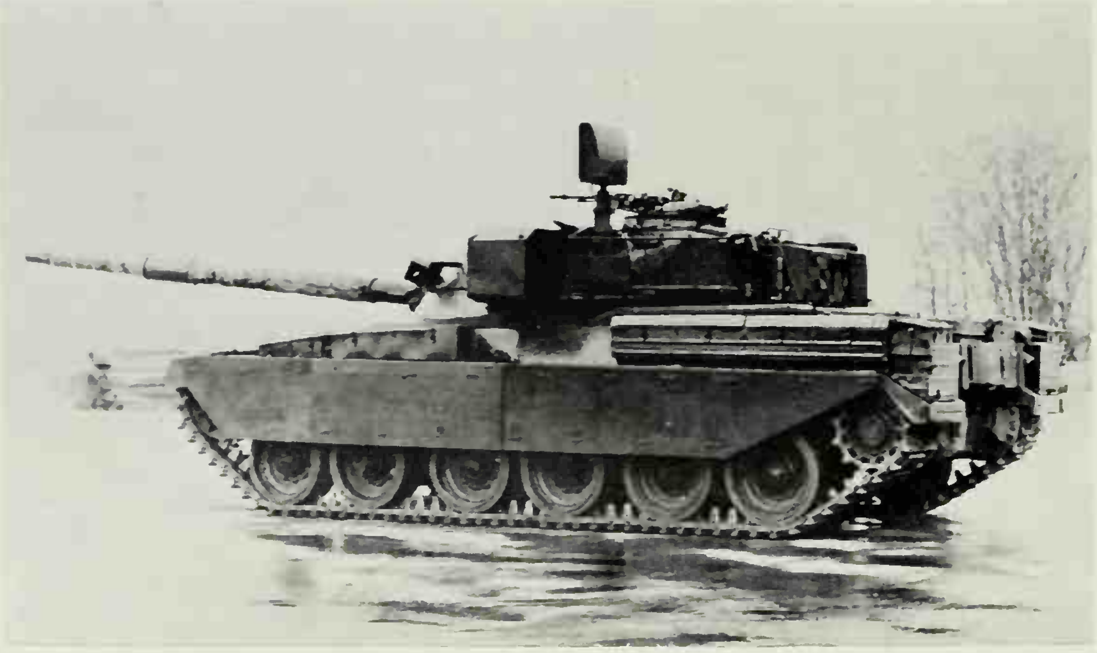
Sensors and control systems for ground forces



ZB 298 in action can be easily concealed, the height of the radar head being adjustable to provide a low silhouette. The remote display unit allows the operator to site himself behind cover



The remote display unit contains all the operator controls. These have been kept to a minimum. Azimuth and elevation indicators are illuminated with Betalights



ZB 298 can be mounted on a wide range of military vehicles. The photo shows a typical mount on a Chieftain tank

Portable radar

ZB 298 for short-range ground surveillance

The ZB 298 short-range ground surveillance radar is designed to meet a UK General Staff requirement which in turn conformed to the NATO basic military requirement for this class of radar.

ZB 298, now in quantity production and currently being delivered to the British Army as Radar GS No 14, Mk 1, meets the long-felt need for an all-weather day and night surveillance radar.

Unskilled operators of ZB 298 after only a few days' training can speedily detect, recognise and provide accurate positional information (azimuth, range and angle of sight) and direction of movement on all forms of moving target on land and over water from a few metres out to 10 000 metres (6¾ miles). Helicopters can also be detected. Furthermore ZB 298 can be employed for observing ground or sea bursts of artillery and mortar fire and the correction of such fire on to both moving and stationary targets.

The system is designed to be carried by two men (or one man in an emergency). It can also be mounted on almost any wheeled or tracked vehicle and operated from within, if necessary with the hatches closed.

ZB 298 is a non-coherent pulsed doppler radar operating in X-band from a 24 V dc supply. Except for a long-life magnetron of proven high reliability, solid-state techniques are employed throughout. The complete system consists of a radar head, tripod, remotable display unit and battery power supply. When man-packed, the display unit clips to the base of the radar head forming a one-man load. The collapsible tripod and the battery carried in the accessory bag form the other load. The radar is inherently rugged and requires no extra protection or special cases for transit.

The equipment can be brought into or out of action in 2–3 minutes: because a magnetron with short warm-up time is used, the radar is ready for operation a few seconds after switching on. All operations of the radar, including movement of the radar head in azimuth and elevation, can be performed from the display unit which can be positioned 20 metres or more away from the radar head. The radar is operated by one non-technical operator, for instance an infantry soldier.

The display unit incorporates a unique solid-state visual display, which allows moving targets to be acquired and tracked, even in the presence of clutter and other interference, such as vegetation moving in a high wind. An audio display (headset) facilitates recognition of the type of movement (man/men walking, running, crawling, wheeled vehicle, tracked vehicle, helicopter, shell-burst, etc). A visor is provided for viewing the visual display in bright sunshine. Azimuth and elevation readouts and the telescope graticules (used for orientation) are illuminated with Betalights to facilitate operation at night.

The following features are also provided:

A confidence check facility which allows the operator to check instantly the correct functioning of the equipment, that line-of-sight conditions exist at any azimuth within radar range and to ensure that the elevation of the antenna is correctly set for optimum signal returns.

1000 metre audio alarm to give warning to the operator of the presence of any moving target over an extended range zone, to minimise operator fatigue.

A search arc indicator so that the operator can see at any time the position of the radar head within a pre-set azimuth sector. Indication is also given when the radar head has reached the limits of the allotted azimuth sector.

Indicators which show when the antenna has not aligned itself in either azimuth or elevation with the control settings. A battery warning lamp lights up when the battery requires changing.

Also developed as part of the system are a training simulator capable of working off a mains supply and permitting the use of up to four standard display units, and test gear which permits rapid fault-finding and check-out using general radar technicians as opposed to specialists.

Specification:

Transmitter and antenna system
Operating frequency: X-band
Antenna beamwidth: horizontal 90 mils; vertical 90 mils
Polarisation: vertical
Output: 2–3 W

Parameters
Range coverage: 50–10 000 metres
Azimuth traverse: 6400 mils electrically controlled from display unit
Elevation limits: ±355 mils electrically controlled from display unit

Display system
Visual display: gallium phosphide display covering any selected 1000-metre range zone. Adjustable in 500-metre steps and incorporating a 50-metre range marker bracket. Fine range control allows adjustment of range to 5 metres
Audio display: headphone signals; audio gate position ganged to 50-metre range market bracket. A 1000-metre audio gate giving audio alarm over selected 1000 metres also incorporated
Range presentation: numerical indicator tubes giving direct range reading in 5-metre steps
Azimuth: direct-reading mils scale (2 mil graduations)
Elevation: direct-reading mils scale (10 mil graduations)

Performance
Maximum range: 10 000 metres
Temperature range: operating −40°C to +50°C; stored −40°C to +70°C
Power supply: UK Army uses Varley 24 V secondary battery, non-spill lead-acid. Alternative batteries to meet special user requirements can be provided

Weights (approximate)
Radar head: 11·36 kg (25 lb)
Display unit: 8·63 kg (19 lb)
Tripod: 10·00 kg (22 lb)
Battery: 10·44 kg (23 lb)

Physical dimensions
Radar head 508 × 483 × 178 mm (20 × 19 × 7 in)
Display unit: 508 × 178 × 203 mm (20 × 7 × 8 in)
Tripod: Length collapsed 610 mm (24 in), max dia 292 mm (11½ in)

Cables
Data (display to tripod): 3 m long or 20 m. A longer cable can be provided if required
Power (display to battery): 2 m (78 in)

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ELLIOTT AUTOMATION RADAR SYSTEMS LTD
Mobile Radar Engineering Division
Elstree Way, Borehamwood, Hertfordshire, England
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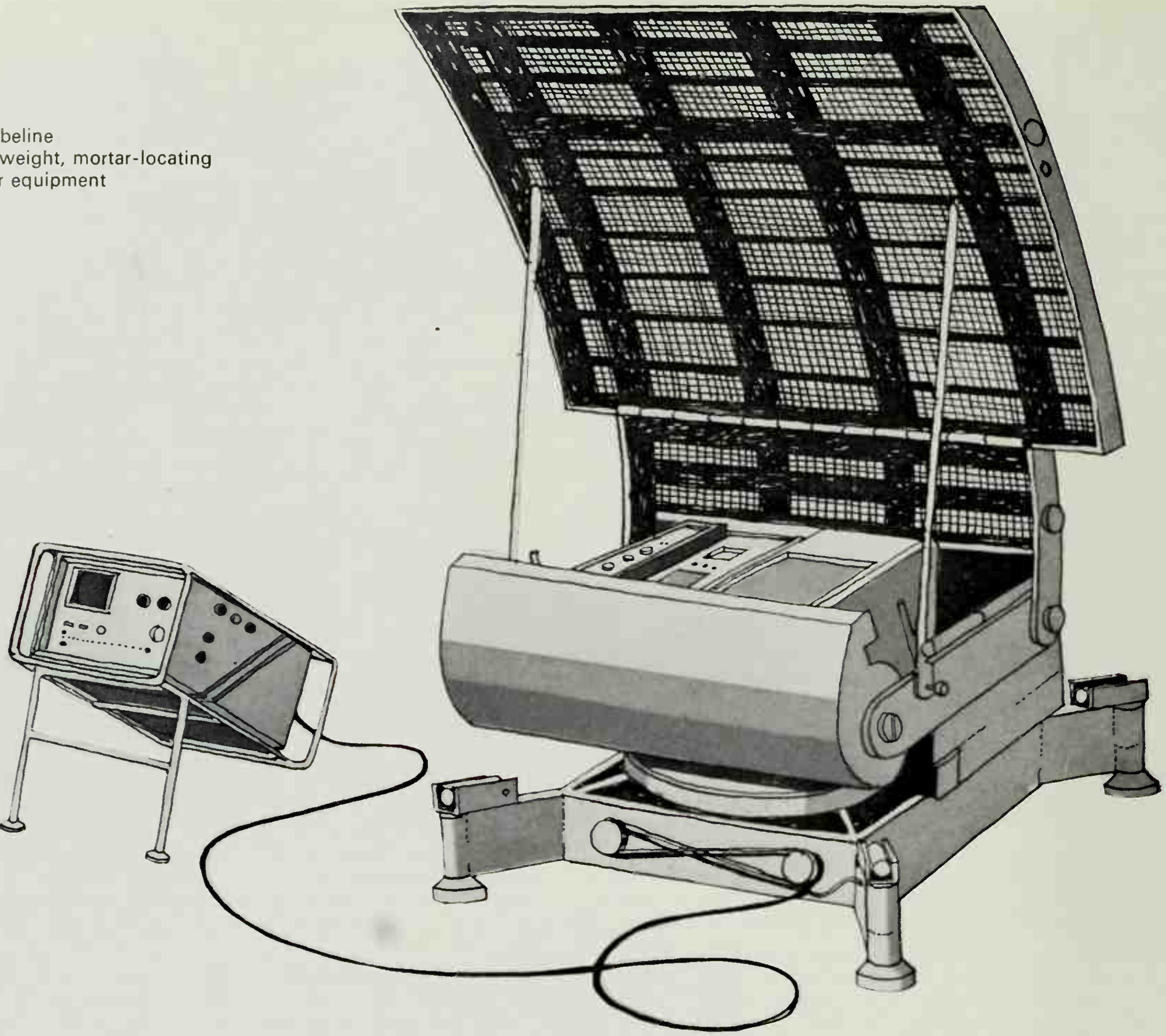
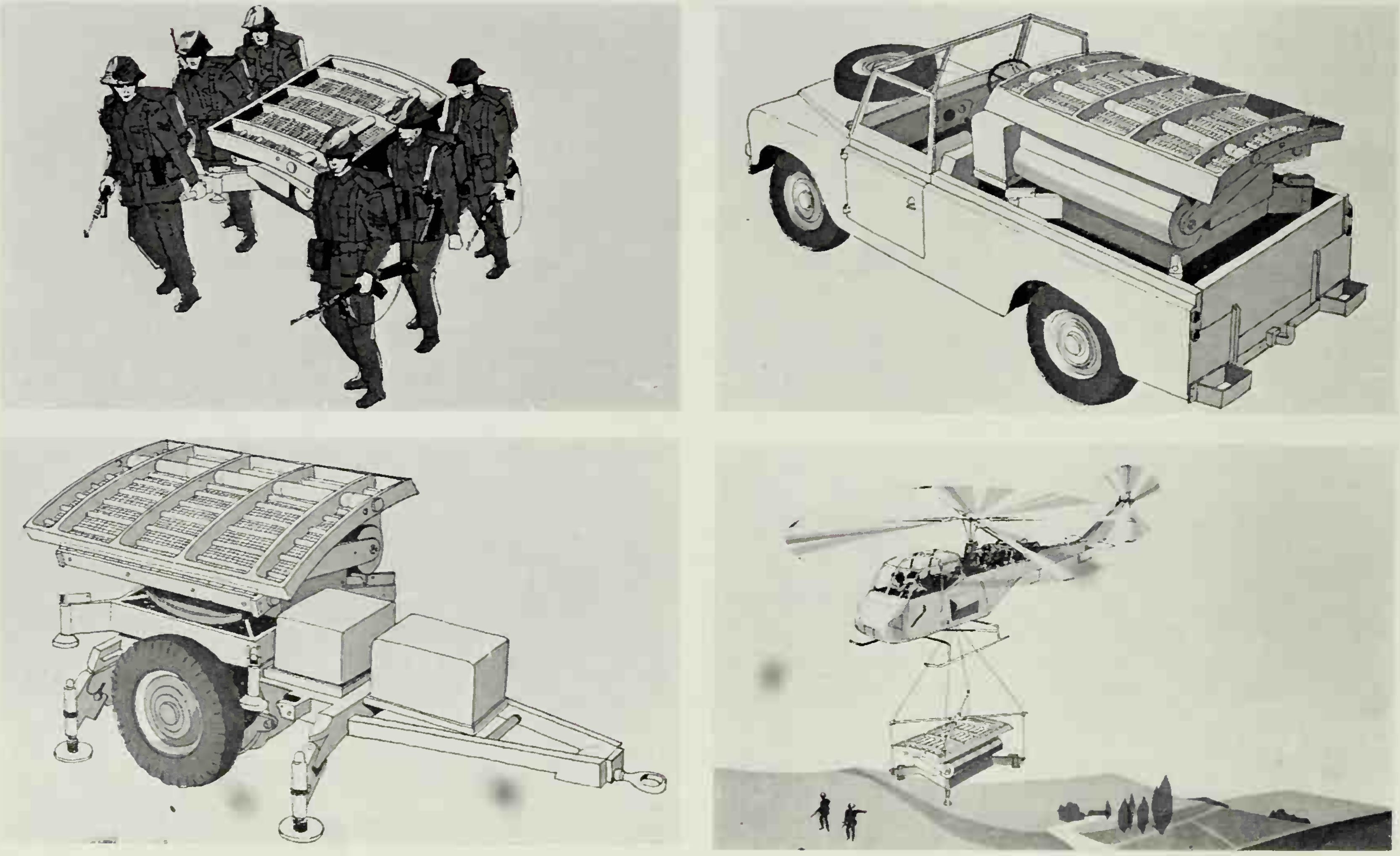
Cymbeline
lightweight, mortar-locating
radar equipment



The equipment can be carried by six men, on a Land Rover, on a trailer or by helicopter



Cymbeline

mortar-locating radar

Cymbeline is a rugged lightweight portable radar for mortar location and for the adjustment of artillery fire. It is a completely self-contained radar system, including its own power supply, with a detachable display unit. The radar is mounted on a four-legged structure supported on screw jacks fitted with hydraulic absorbers.

The antenna system consists of a Foster scanner which illuminates a parabolic cylinder reflector and produces a pencil beam scanning in azimuth. The complete radar head can be rapidly rotated to cover any required sector; for example, 180 deg rotation takes only 15sec. When in transit the reflector folds down.

Below the antenna is an equipment box which houses the main radar unit, the power unit and the display unit during transit. The main radar unit contains the transmitter/receiver and the radar timing and computer modules.

The display unit can be removed from the equipment box for remote operation for distances up to 16m (52ft). It consists of a short-persistence 'B' scope on which the radar returns are displayed. It also carries all the controls necessary for the operation of the radar. The mortar co-ordinates are shown on another unit which is detached and can be used at distances up to 2m (6ft) from the display.

The radar can be operated from any 1kVA dc supply at 24V ±4V. However, provision has been made for either a Wankel gasoline engine-driven generator or a hydrazine air fuel cell unit to be mounted on the equipment. These two units are being separately developed as alternatives.

Specification

Physical

Weight of radar: 205kg (440lb)
Weight of power supply (generator or fuel cell): 65kg (146lb)
Height (stowed): 100cm (39½in)
Height (operational): 220cm (87in)
Length: 175cm (69½in)
Width: 160cm (63in)

Radar system

Frequency: X band
Aerial: Foster scanner with reflector
Bearing limits: 9600mils total rotation

Performance

Location range: out to 10 000m (11 000yd)

Reliability

Radar reliability: 200h MTBF (excluding power source)
Electronic units: fully sealed and dessicated with air-to-air heat exchangers

Power units

Alternative 1, Wankel generator: weight, 65kg (146lb); reliability, 200h MTBF. Silence: inaudible at 100m (330ft) on a still day and in tropical night conditions
Alternative 2, fuel cell: weight, 65kg (146lb); reliability, 500h MTBF

Operating limits

Temperature: –46 to +52°C
Altitude: sea level to 3000m (10 000ft)
Wind conditions: no loss of accuracy up to 80km/h (50mph). No damage up to 160km/h (100mph)

EMI ELECTRONICS LIMITED
Military Division
Hayes, Middlesex, England
Telephone: 01-537 3888 Cables: Emidata London Telex: 22417

EMI

1968

FACE

computer system for artillery fire control

FACE (Field Artillery Computer Equipment) is a mobile computing system for use in battery command posts and artillery survey computing centres to automate the procedures associated with the preparation of gun firing and survey data. Advantages over manual methods include speed, elimination of human error under battle conditions and improved accuracy.

FACE was developed in conjunction with the Royal Armament Research and Development Establishment and the School of Artillery at Larkhill.

Gun data role

In this role all the information required to place a shell accurately on target is processed by the computer and displayed on the console. A single system can process information relating to two batteries, each containing up to eight guns, and in addition can deal with three other batteries, treating each battery on a battery centre basis.

For each calibre of weapon in the gun data role and for the artillery survey role there is a program tape stored in a sealed cassette, and the data on this tape can be read into the computer by the program loading unit within two minutes.

Artillery survey role

In this role, the calculations necessary for artillery survey are carried out.

Maintenance and repair

No routine maintenance is required. A test sequence in the program for each role provides the operator with a confidence check. A complete engineers' test program is available for diagnostic testing of computer and console. Use of these test facilities enables a fault to be traced to the defective unit. Furthermore, test sets have been developed which enable the fault to be isolated to a sub-unit, such as an electronic circuit panel.

For the computer, a test set is available which simulates the control waveforms generated in the computer, and enables a technician with no knowledge of the computer to carry out comprehensive fault-finding.

Interference

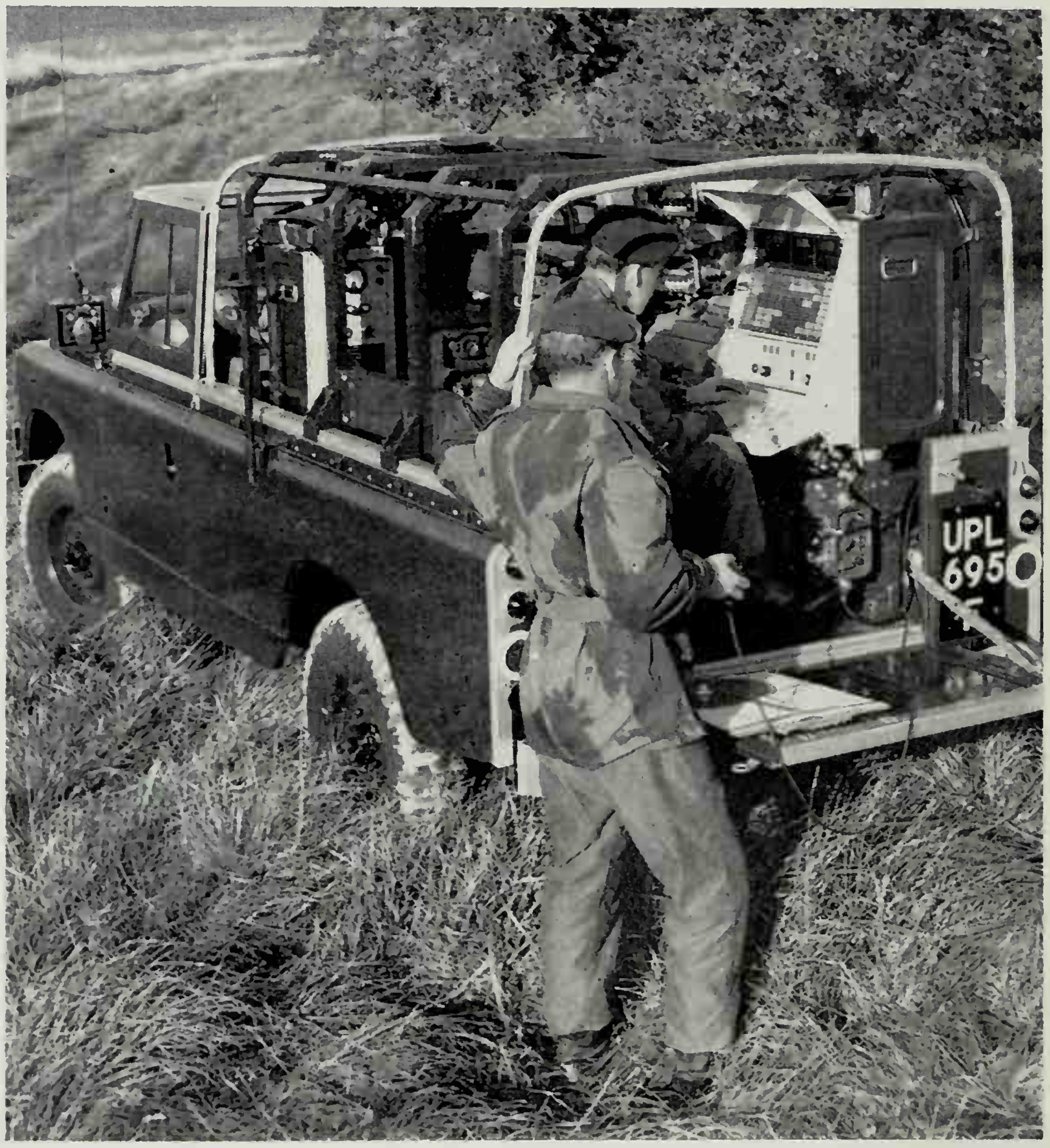
FACE is fitted with RF suppression and can be used in the vicinity of radar and high-powered communications equipment.

It is not affected by radiation at levels below 10mW/cm².

Technical data

Power consumption
In normal operation: 300W

Environment
Complies with Def. Spec. DEF 133/L3



FACE computer system installed in a long-wheelbase Land Rover. Other British vehicles for which FACE installation kits are available include the FV432 and FV610

Weights and dimensions

Unit	Weight kg	Weight lb	Dimensions Width mm	Width in	Depth mm	Depth in	Height mm	Height in
Computer	45	100	490	19·2	230	9·0	820	32·0
Console	36	79	490	19·2	470	18·6	590	23·0
Power supply unit	37	81	260	10·1	410	16·0	590	23·0
Program loading unit	20	44	450	17·5	310	12·2	310	12·2
Teleprinter	23	51	540	21·0	560	21·8	360	14·1
Teleprinter inverter	14	31	220	8·6	240	9·4	220	8·6
Supply control unit	9	20	220	8.6	170	6·6	220	8·6
Teleprinter line adapter	5	11	220	8·6	170	6·6	180	7·0
Battery	83	183	610	23·8	350	13·7	310	12·2

Temperature
All units can work under ambient temperatures from –32 to +52°C

Installation
All units can be installed in one vehicle

Sealing
All units are fully sealed

A GEC-Marconi Electronics Company
MARCONI SPACE AND DEFENCE SYSTEMS LTD
Military Division
Chobham Road, Frimley, Camberley, Surrey, England
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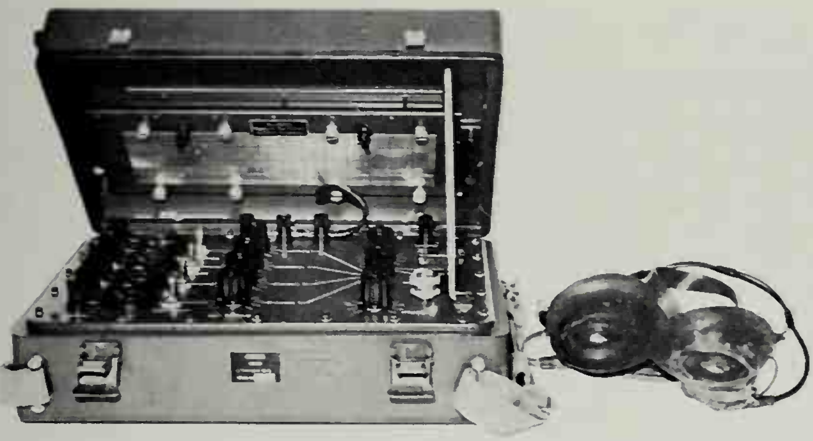
Seismic detectors

and intruder alarm systems

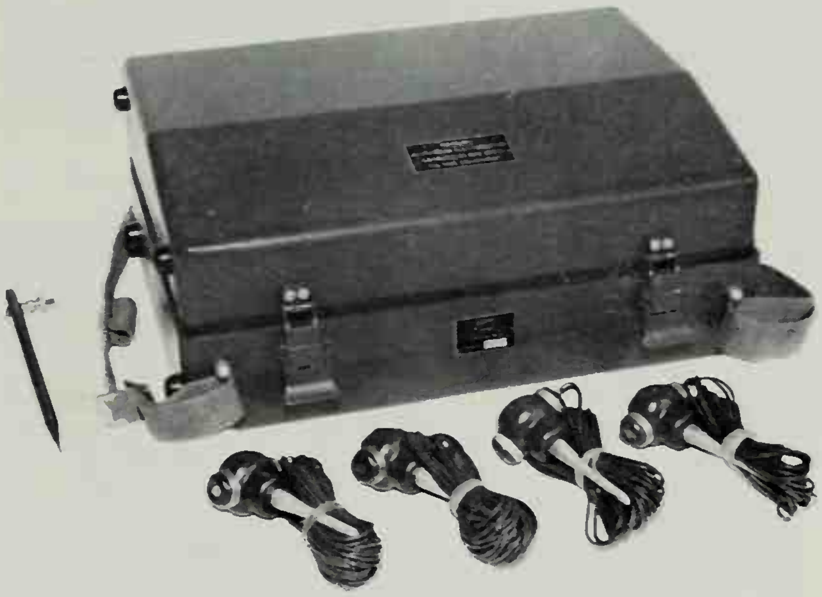
TOBIAS intruder alarm system

The TOBIAS seismic intruder alarm system is designed to provide a small, easily portable, all-weather day and night surveillance system which does not require line-of-sight conditions, to meet the needs of all those involved in security, whether on the battlefield or for frontier or perimeter protection. It makes use of small, rugged, low-cost, passive sensors (geophones) which, because they are buried below ground level, are virtually undetectable. They may be sited near likely intruder approach routes or round a perimeter. Their deployment area can be many miles from the display unit. TOBIAS has four independent channels on each of which up to 20 geophones may be connected. Thus, if desired, a considerable frontage or perimeter can be protected by one system. Maximum detection distances for one geophone depend largely on the nature of the ground and the amount of natural and man-made seismic activity in the area, but for a walking man this is seldom less than a circle of radius of 50 metres round the sensor. Distances considerably in excess of this have been frequently achieved and circular detection patterns of 300 metres radius or more are not uncommon. Visual indication of movement on each channel is provided at the display unit; an aural display (headset) also allows the nature of movement on each channel to be recognised (man, animal, vehicle, etc). The aural display also allows operator to monitor activity on all four channels continuously and simultaneously. Power supply (contained in lid of display unit) is eight 1½ V standard U2 (or equivalent) cells, which provide a minimum of 72 hours' continuous operation.

Dimensions and weights
Geophone:
  Width 3·8 cm (1½ in)
  Overall height, including spike 12·7 cm (5 in)
  Weight 163 grammes (5¾ oz)
Display unit:
  Width 37·2 cm (14⅝ in)
  Depth 28·9 cm (11⅜ in)
  Height 15·9 cm (6¼ in)
  Weight (excluding batteries) 5·5 kg (14¼ lb)



TOBIAS display unit, showing display panel and headset



TOBIAS display unit, ready for carrying, shown with four geophones

AIDA intruder alarm system

To eliminate the need for continuous monitoring and at the same time to provide an effective intruder warning system in areas of high seismic activity (urban areas, industrial estates, etc), Elliott Automation has developed AIDA, an automatic intruder alarm system.

Again, seismic sensors are used which may be deployed singly or in arrays buried in the ground, or attached to fences, gates, etc. The display console, which can be mounted on racks in a guardhouse or other building, can be set to provide an automatic alarm signal on, say, a man walking or crawling but not to react to interfering signals from sources such as road traffic, trains, machinery, etc. Alternatively the alarm could be passed down a telephone wire to a remote site or headquarters.

The equipment includes comprehensive monitoring facilities which check correct functioning and, with a fail-safe facility, gives an alarm in the event of an attempt to interfere with the geophone arrays and connecting cables. As with TOBIAS, provision is made for the operator to monitor the alarm signal and thereby establish the nature of the intrusion.

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ELLIOTT AUTOMATION RADAR SYSTEMS LIMITED
Mobile Radar Engineering Division
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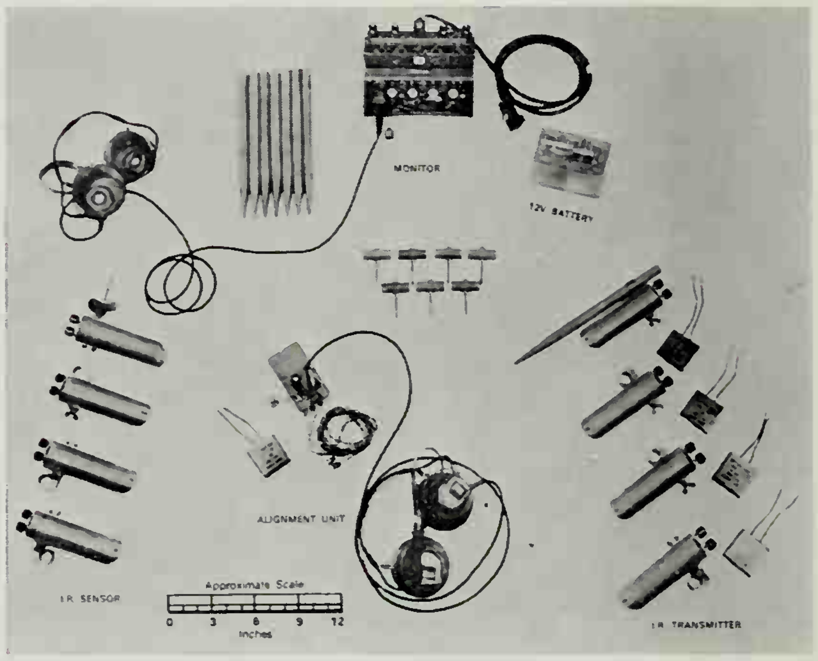
IRIS

Infra-red intruder system

Knowledge of the enemy's movements is essential. IRIS has been specifically designed to meet this requirement and to offer a light, low-cost, reliable and rugged equipment requiring the minimum of technical ability to set up and operate efficiently in the field. It can be powered from any convenient 12 V dc supply. Delay circuitry has been built in to overcome false alarms such as birds flying through the beam.

The basis of the system is an infra-red beam projected between a transmitter and a sensor; interruption of the beam causes an alarm to be triggered at a remote monitoring unit. The beam is extremely narrow and it is virtually impossible to detect without interrupting reception by the sensor. The effective part of the beam is a narrow cylindrical 'pipe' about 40 mm (1½ in) in diameter connecting the transmitter and sensor which must be completely obscured to give an alarm. In particular, the transmitter and sensor may be hidden in light foliage, amongst or behind small twigs and branches, etc. IRIS can be used both during day and at night over ranges of 200 m in average conditions. Even in fog, snow or tropical rain, a range of 50 m may be obtained.

The system is designed to be 'fail safe' in that damage or destruction of either transmitter or sensor, disconnection of the battery, or the cutting of the signal cables leading to the monitor will automatically indicate an alarm condition.



Above: the complete IRIS equipment, showing the headset in alternative positions

Below: monitoring the IRIS infra-red intruder system

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Mobile Radar Engineering Division
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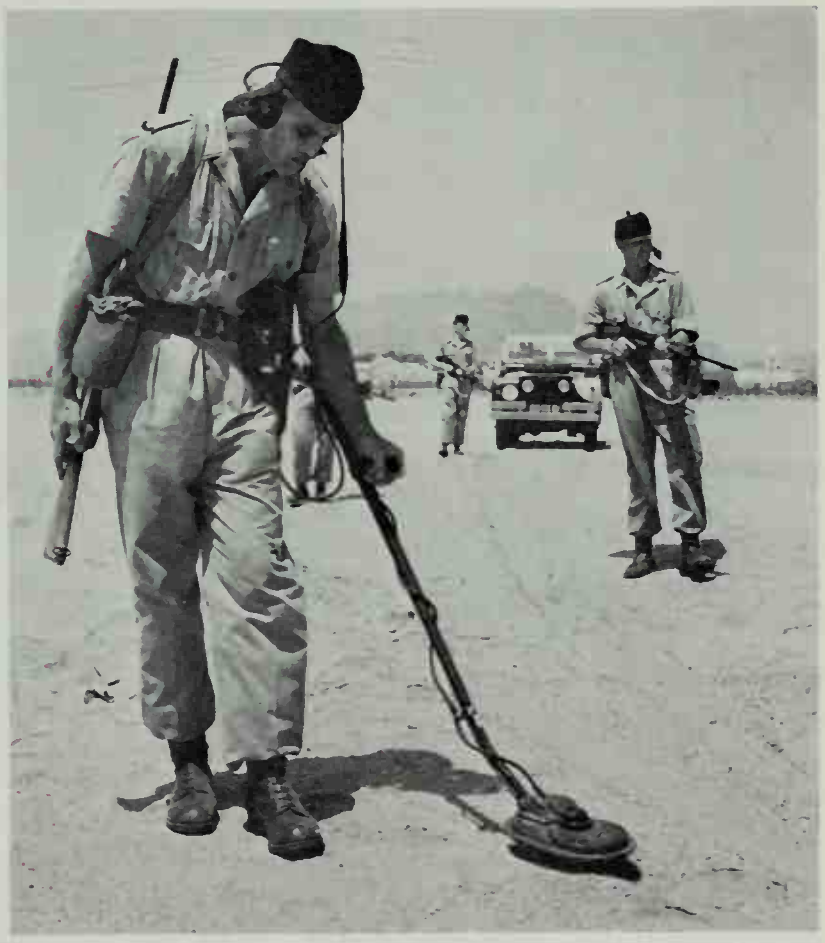
Mine detector

New lightweight model

Mine detector No 4C

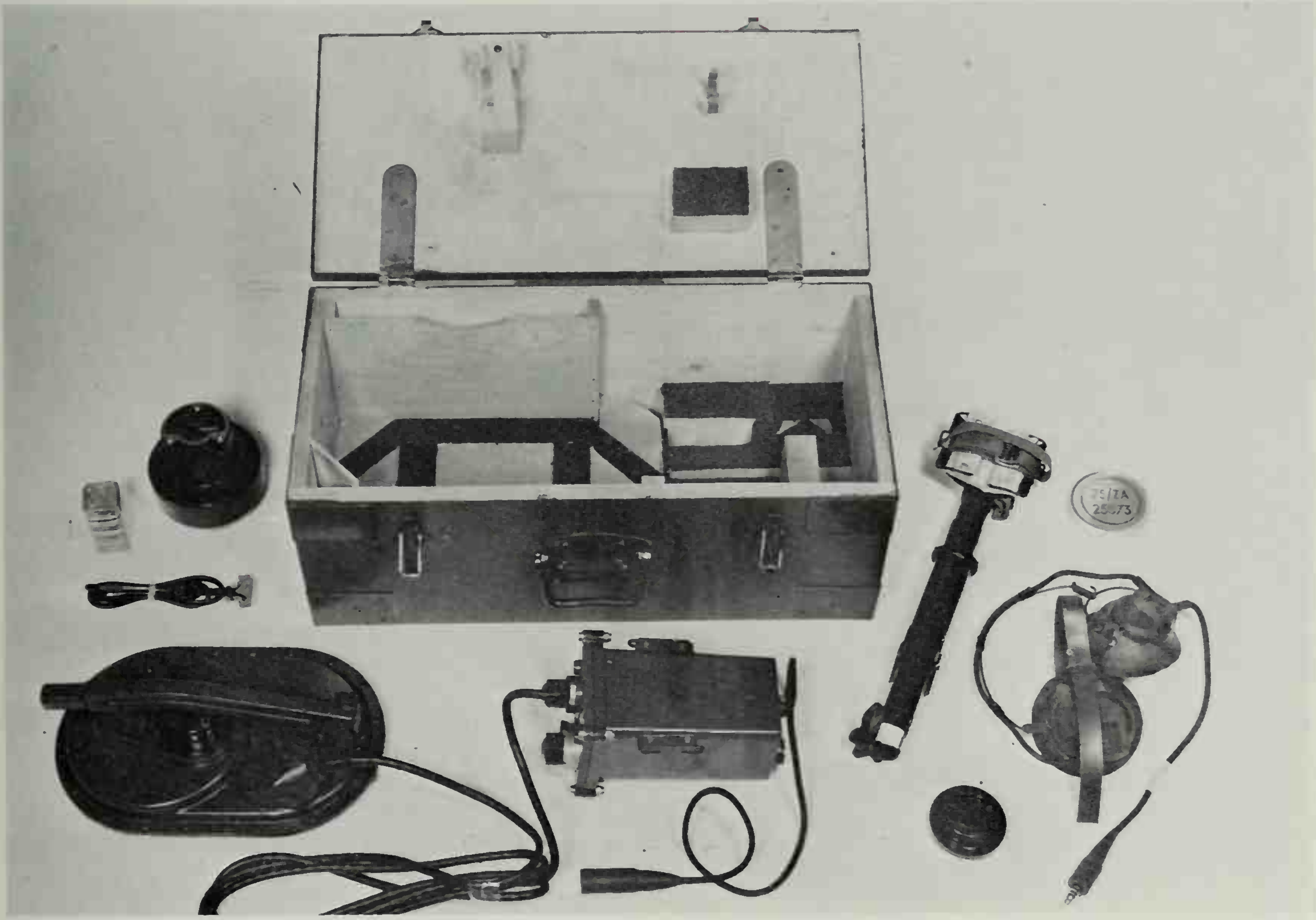
The mine detector No 4C, now in general service with the British armed forces and the armed services of many other nations in all parts of the world, is the logical development of the well-proven models 4 and 4A. The most important innovation is the replacement of the thermionic valve-operated amplifier by a transistorised unit of modern design, and the fact that the control box is incorporated in the amplifier. As a result the entire equipment is now much lighter, the amplifier weighing only 1·8 kg (4 lb) complete with battery, and much more compact and insensitive to mechanical shock and vibration.

The mine detector comprises a search head mounted at the end of a telescopic pole (or handle), an amplifier unit and headphones, together with all interconnecting cables. For transport these are stored in a robust wooden transit case, which also contains a spare battery, test boxes, extension cable and other accessories.



Right: an assault pioneer of the Cameronians (Scottish Rifles) using a mine detector No 4C to search for mines

Below: the mine detector No 4C with all accessories and carrying case

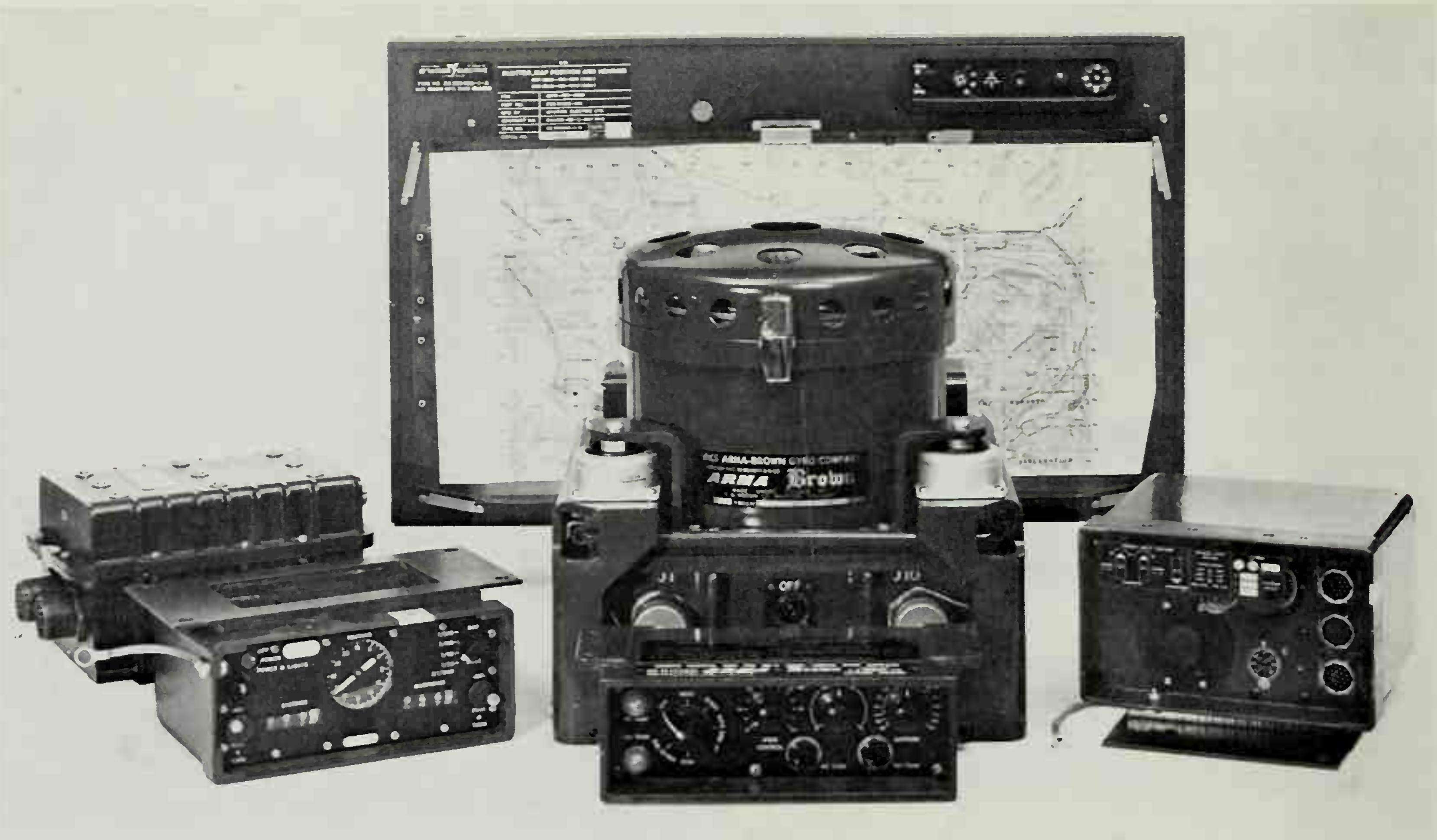


A Division of United Scientific Holdings Ltd

UNITED SCIENTIFIC INSTRUMENTS LTD

Kirkman House, 54a Tottenham Court Road, London, W1P 0BQ, England

Telephone: 01-636 5905 Cables: Scodil London W1 Telex: 265403



Above: LNS 101 equipment showing standard units

Below: the Chieftain tank is fitted with LNS 101 equipment

Land navigation systems

for military vehicles

Conditions of modern warfare demand that small units should be able to move rapidly about the battlefield under all conditions, but particularly at night or when visibility is poor.

LNS 101 is a land navigation system that has been developed by the Aviation Electric Company using the Arma-Brown gyro compass as the standard heading reference. A second system (LNS 102) is available, using a magnetic heading transmitter where conditions of use do not warrant a gyro compass.

Advantages

These land navigation systems accurately and continuously compute and display the geographical location of the vehicle and the direction in which it is headed. The presentation is designed to let the commander use the information immediately without need for any manual plotting or calculating.

The LNS makes it possible for crews of tanks and any other vehicles to navigate across unknown country quickly and easily even when features on the ground cannot be seen, as for instance in darkness, fog or smoke or when hatch covers must be kept closed. It also enables vehicles to navigate accurately in country devoid of landmarks, where reliable maps are not available or in areas lacking permanent topographical features. It permits the position of the vehicle to be quickly and accurately reported without map reading.

The LNS 101 is supplied to the British, Canadian and US Armies for operational use in tanks such as the Chieftain and Centurion, and armoured personnel carriers such as the M113A1

The advantages of using a self-contained dead-reckoning system have been firmly established. While armoured vehicles have received priority in respect to fitment of land navigation equipment, it has become increasingly evident that the ability to navigate under adverse conditions can be equally important in other vehicles used under combat conditions.

Method of operation

The continuous computation and display of the present position of the vehicle is obtained by automatic dead-reckoning from a known starting point. The distance travelled by the vehicle is measured by the odometer drive, while the direction of travel of the vehicle is derived electrically from either a gyro compass or a magnetic heading transmitter.

Prior to moving off, the starting point co-ordinates, obtained from a standard military map grid, are set into the appropriate units. Any subsequent movement of the vehicle is continuously followed and displayed.

Specification

Power requirements
24 V dc obtained from vehicle battery
Computer and all display units only: 2 A max
LNS 101 System: 5 to 12 A running
LNS 102 System: 4 A max

Range of operation
Computer: no limit
Indicator, heading and position: no limit
Plotter, vehicle position: map area:
Scale 1/25 000 10 km (E/W) × 8 km (N/S)
Scale 1/50 000 20 km (E/W) × 16 km (N/S)
Scale 1/100 000 40 km (E/W) × 32 km (N/S)
Scale 1/250 000 100 km (E/W) × 80 km (N/S)

Speed range
Zero to 95 km/h (60 mph)

Accuracy
Within 50 meters or 1% distance travelled, whichever is the greater

Operating conditions
The equipment is designed to meet the following environmental conditions in accordance with Canadian Army specification CA-E126, 10 May 1962 and US Army MIL-N-52549 (ME) 4 January 1967 and US Army TECP 700-700, 8 March 1967, extracts of which are briefly stated below:

Temperature: from −65°F (-54°C) to +150°F (+65°C)

Humidity: up to 100% relative humidity at varying temperatures wherein condensation takes place on the equipment in the form of both water and frost

Moisture: prolonged exposure to driving rain or snow and total immersion in fresh or salt water at covering depths up to 0·91 m (3 ft) for 2 hours

Dust and sand: dust and sand particles as small as 10 microns in size in any concentration likely to be encountered in service

Vibration: in accordance with CA-E126 and US Army TECP 700-700

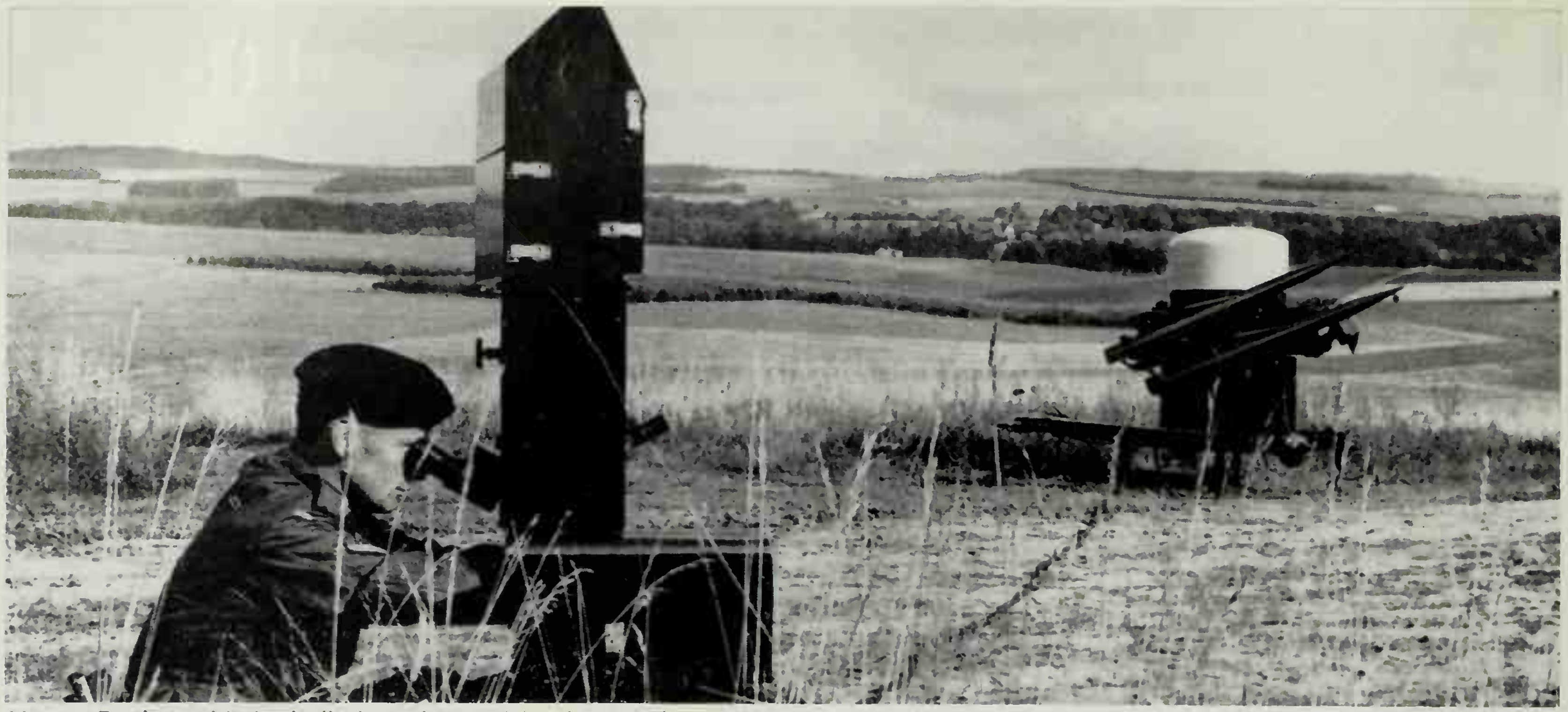
Shock: shock of the type encountered in any type of military vehicle moving over extremely rough terrain. Also, shock resulting from ballistic impact when mounted in an armoured vehicle

Orientation: any

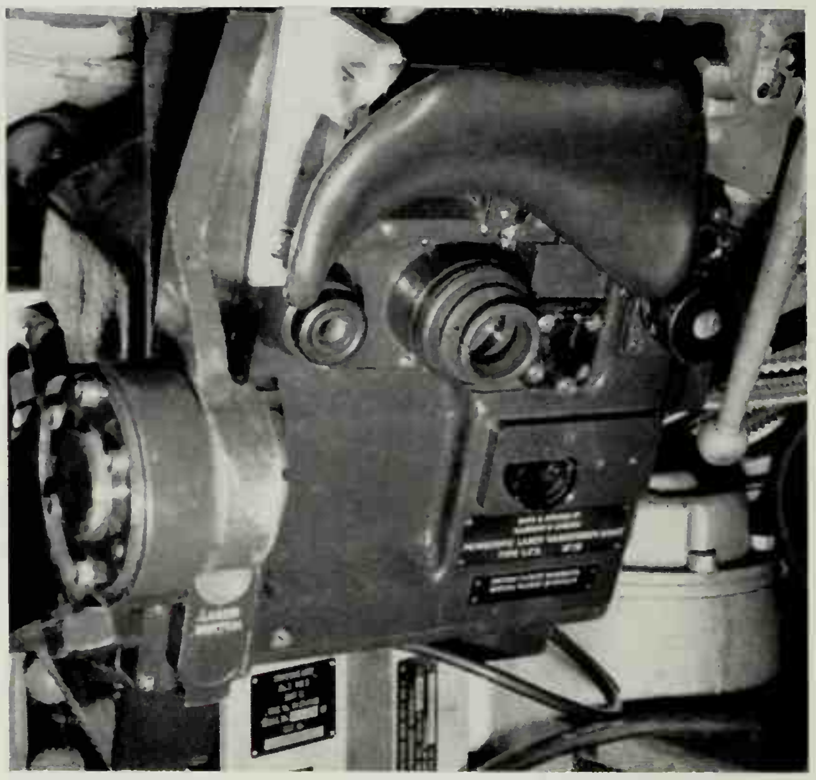
Altitude: up to 3050 m (10 000 ft) above sea level

A Hawker Siddeley Company

S G BROWN LIMITED
Greycaine Road, Watford, Hertfordshire, WD2 4XU, England
Telephone: Watford 27241 Cables: Sidbrownix Watford Telex: 23408



Above: Rapier guided missile launcher and Rapier tracking system

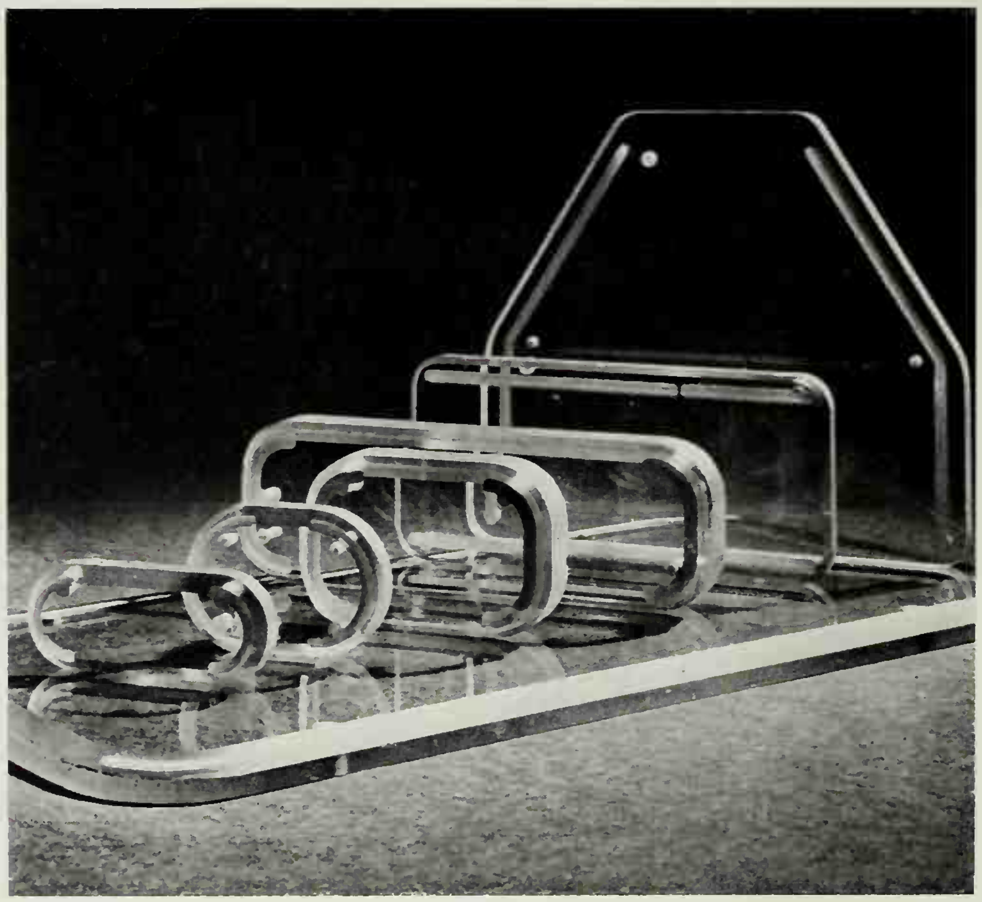


Above: Installing a laser rangefinder in a tank

Above: Inside tank view of laser rangefinder

Below: Infra-red binocular sight

Below: Wire-heated windows



Optical equipment

Sights, laser rangefinders and special optics

Rapier tracking system

Barr & Stroud Limited has been responsible for the design and manufacture of the sighting optics and line-of-sight drive mechanisms for the servo-optical section of the tracker unit used in the Rapier tracking system.

The servo-optical section consists of an optical system with associated drive mechanisms and servo controls. It is the precision manufacturing and careful alignment of these optical and mechanical assemblies which enables the operator to direct the line of sight sufficiently accurately for the missile to hit the target.

Many difficult engineering and optical problems have had to be overcome to satisfy the required level of accuracy necessary for the Rapier tracking system.

The sighting optics and line-of-sight drive mechanisms for the servo-optical section of the tracker unit are designed to match the complete Rapier tracking system for stability and durability. Consideration was also given at design stage to the extreme climatic conditions which are experienced in military service.

Laser rangefinder LF2

LF2 is a fully engineered laser rangefinder designed for use in a tank; it can be fitted to other vehicles where space permits.

It is designed in conventional tank gunner's sight style, combining the function of a laser rangefinder with conventional tank sight optics. Thus the gunner has only to locate and sight on a target, then press the laser firing button to obtain a range. Range read-out is afforded by an eyepiece positioned to minimise head movement.

The equipment consists of two separate units: (1) the combined laser and sight unit containing the sighting equipment, laser transmitter, receiver and associated electronics; (2) the power unit.

Laser rangefinder LF2 is of robust construction to withstand vibration and extreme climatic conditions experienced in military service.

Driver's infra-red binocular sights

Driver's sights CU9, CU10 and CU13, permit night driving of military vehicles without using a visible form of illumination. These sights are binocular periscopic instruments differing only in the position of their exit beams which are angled to give optimum driving comfort for different driving positions. They afford stereoscopic vision and have large exit pupils providing vision comfort.

The sights convert the radiation from the vehicle's infra-red light source into visible light and because of the wide field of view combined with wide-aperture optics, driving at night using the sights compares favourably with night driving using a visible form of illumination.

The sights are robust instruments, designed to withstand vibration and extreme climatic conditions experienced in military service.

Wire-heated windows

Barr & Stroud wire-heated windows are particularly suitable for military sighting instruments where exceptional optical performance and electrical reliability are required. These precision-made yet rugged windows do not have diffraction effects, and retain definition throughout their operating temperature range, typically +65 to −50°C.

Light transmission is not less than 90% and there are none of the grading and delamination problems frequently associated with conducting film windows. Windows are available in a variety of shapes and sizes; thermostatic control can be provided.

Infra-red materials

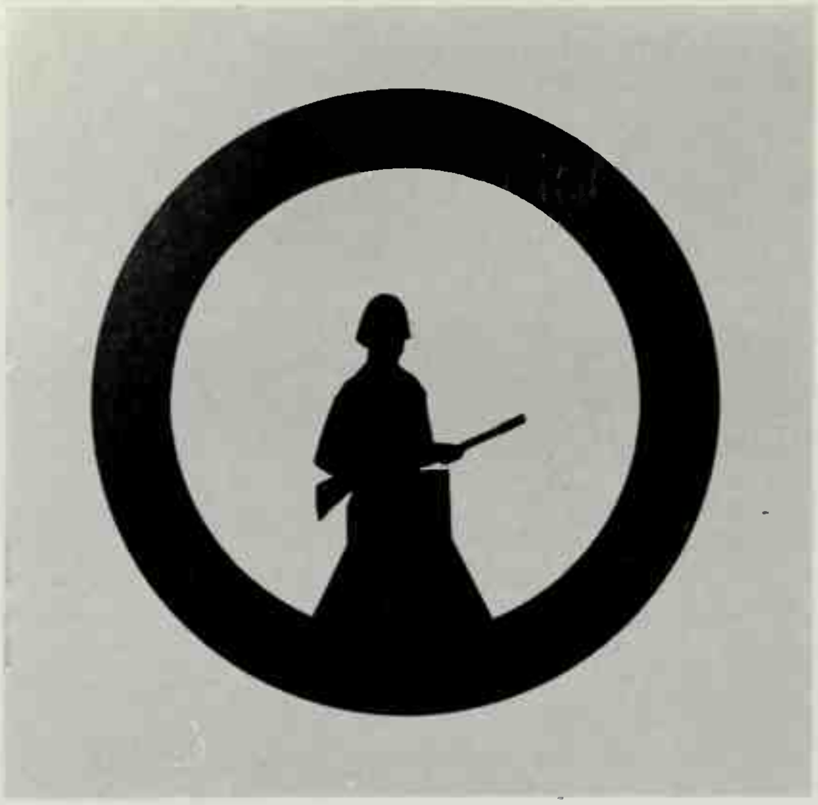
Calcium aluminate glasses transmit from the ultraviolet to over 5μ and combine high strength and hardness with resistance to abrasion and thermal shock.

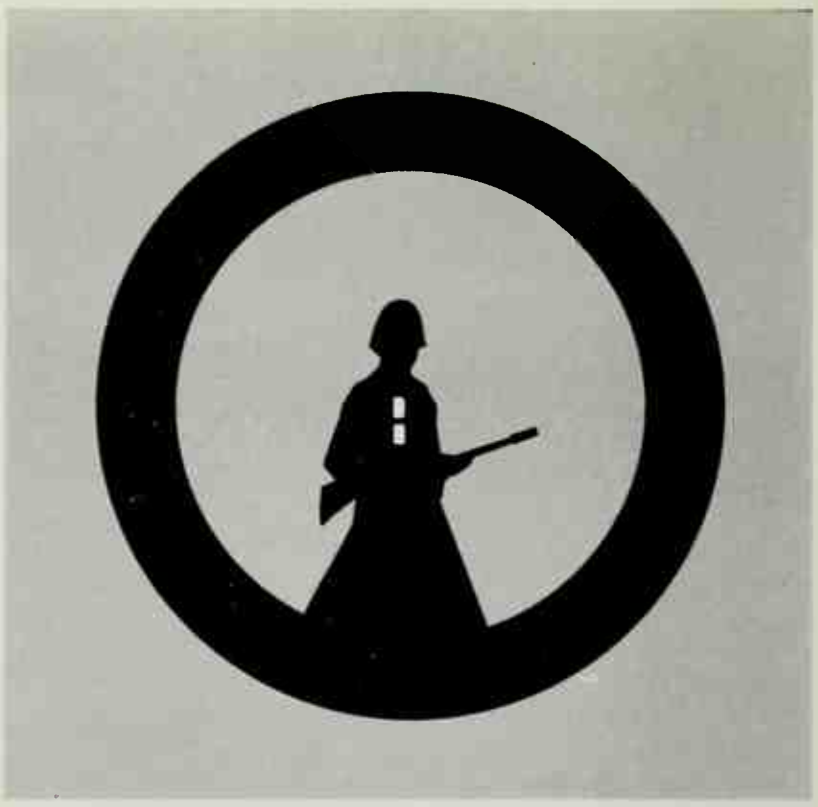
A new arsenic triselenide glass transmits well from 1·5 to 16μ and when anti-reflection coated has over 90% transmission in the 8–14μ band.

Other materials are available and all can be supplied in a variety of forms including domes, lenses, prisms and plates.

BARR & STROUD LIMITED
Caxton Street, Anniesland, Glasgow W3, Scotland
Telephone: 041-954 9601 Cables: Telemeter Glasgow Telex: 778114

BARR AND STROUD





The problem
All soldiers know the difficulty of aiming at night, or when there is not enough light to line their sights with the target.

Unless his sights are illuminated the firer must rely on rough weapon alignment with only a small chance of hitting the enemy.

Illuminated sights are therefore essential, but while being easily seen by the firer they must not be so bright, or so positioned, that they interfere with his view of the target under difficult night conditions.

The illuminations must also be self-energising, free from deterioration (as occurs with luminous paints), free from radio-activity hazard and long-lasting.

The Trilux night sight meets all these requirements. It is unique, simple, safe, adaptable, long-lasting and robust.

The solution
The Trilux night sight consists of: Foresight. The blade incorporates a luminous glass tube, coated on the inside with phosphorus which is activated by tritium gas. The glass tube is manufactured for the Royal Small Arms Factory by Saunders-Roe Developments Limited. It has the following advantages:
Its brightness can be varied in manufacture to meet the requirement; its size allows it to be adapted to all known weapon foresights; the illuminant is completely sealed; it has a long half life of 8–10 years.

Various configurations of foresight blade as made at the Royal Small Arms Factory are illustrated.

Backsight. This incorporates a large aperture of the optimum size to match the requirement of the night-adapted eye. As with any small daylight aperture the firer instinctively places the illuminated foresight in the centre of the aperture.

Ease of use
The technique of firing is simple and a trained soldier can be instructed in a matter of 10 minutes.

Effectiveness
World-wide trials by the British Army show that, under light conditions where a man-sized standing target can just be seen between 20 and 50 metres, the average firer will score 70 per cent hits.

Using Trilux night sights a soldier can effectively engage all targets out to the furthest distance at which he can see them:
From 15 metres—dark night and background.
To 300 metres—light night and background.

Apart from its night-firing advantage the Trilux night sight increases accuracy in poor daylight conditions and in 'quickfire' engagements.

Security
The luminous tube is concealed from direct view by the enemy, and field tests have shown that the sight does not give away the firer's position at night.

Adaptation to your weapons
In addition to the British Army rifle and machine gun, sights have been made and fitted to a number of overseas weapons including the Colt AR15, Heckler and Koch G3, FN's FAL, the US M1 and M14 and the Italian BM59 (M1, 7·62 conversion). The system can either be in the form of clip-on-sights, or permanently fitted replacement for the existing iron sights.

Further information and quotations for the Enfield Trilux night sights can be obtained from the Director of Sales (A), Ministry of Defence, at the address given below.

MINISTRY OF DEFENCE
Director of Sales (Army)
St Christopher House, Southwark Street, London SE1, England
Telephone: 01-928 7999

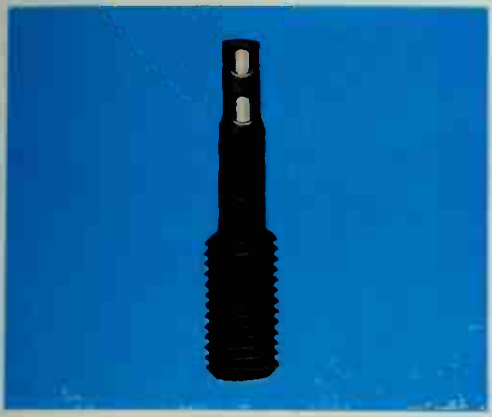
RSAF

Night sight

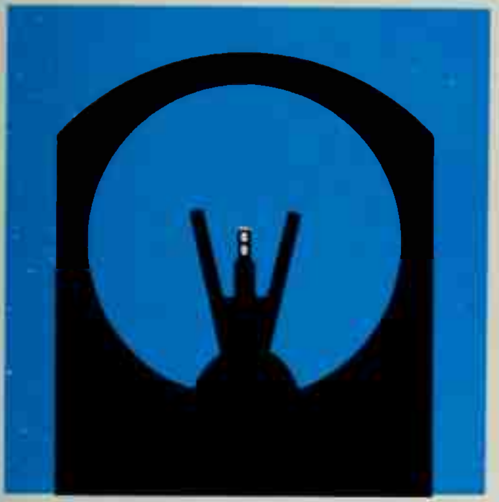
Trilux foresight for shooting in the dark

Typical foresight arrangements

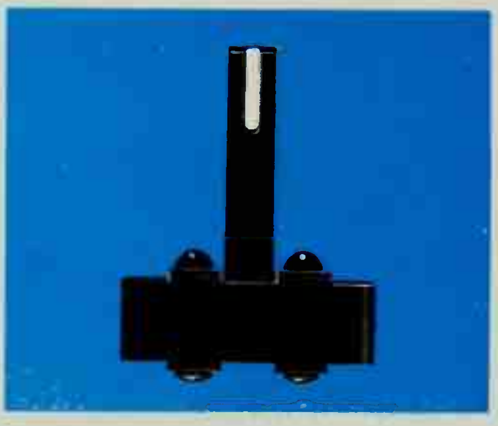
L1A1 rifle and FAL rifle



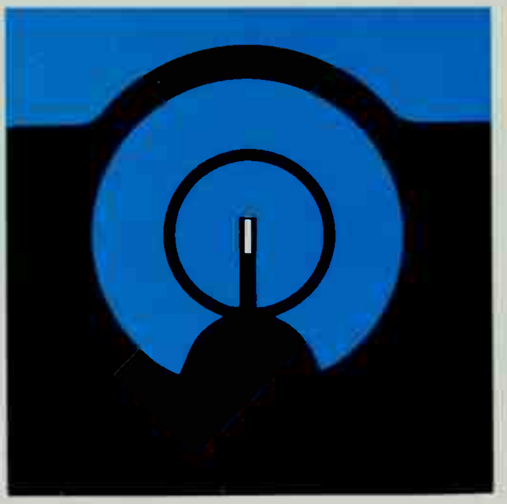
Flat-sided pillar-type adjustable for elevation zeroing. A Trilux tube is mounted centrally for maximum protection, with two 'portholes' facing the firer



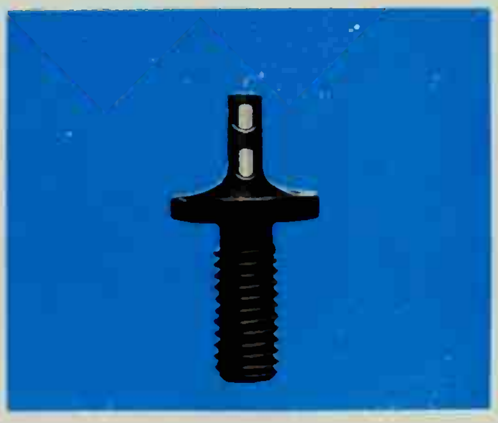
German G3 rifle



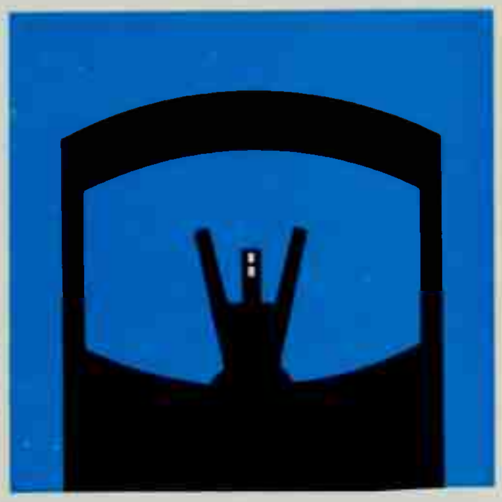
A fixed block, or clip-on-blade type with a Trilux tube mounted in the backward-sloping rear edge of the blade, and visible through either a narrow slit, or portholes

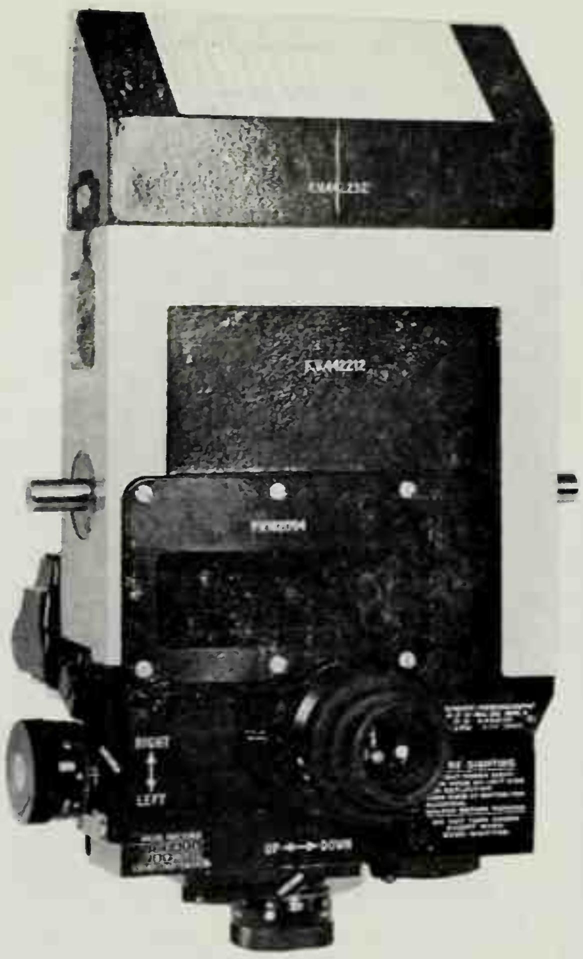


US AR 15 rifle

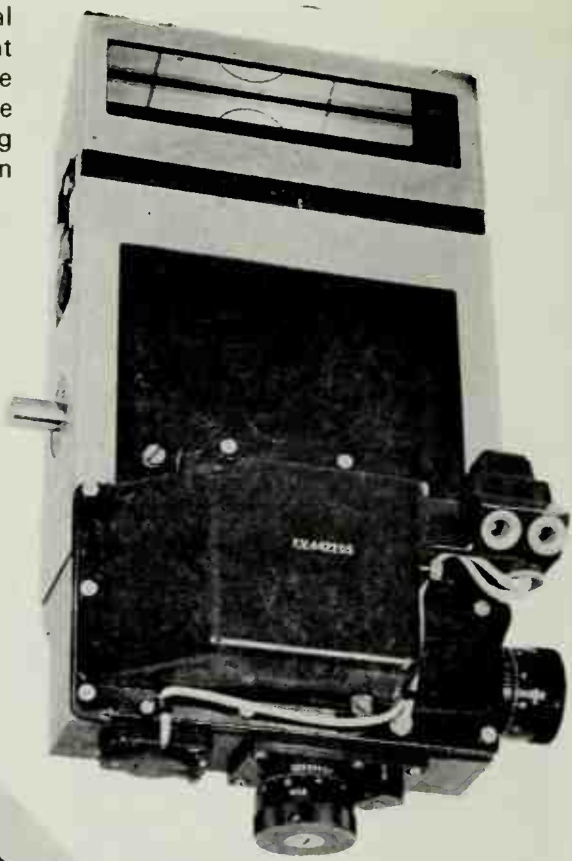


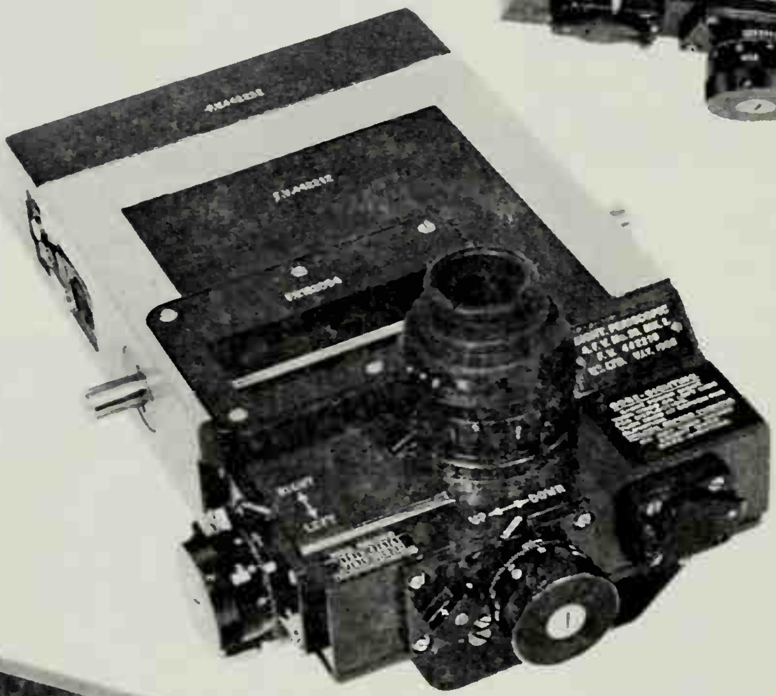
Adjustable pillar-type, with portholes, similar to the L1A1. Trilux sights for other rifles and machine guns are also available

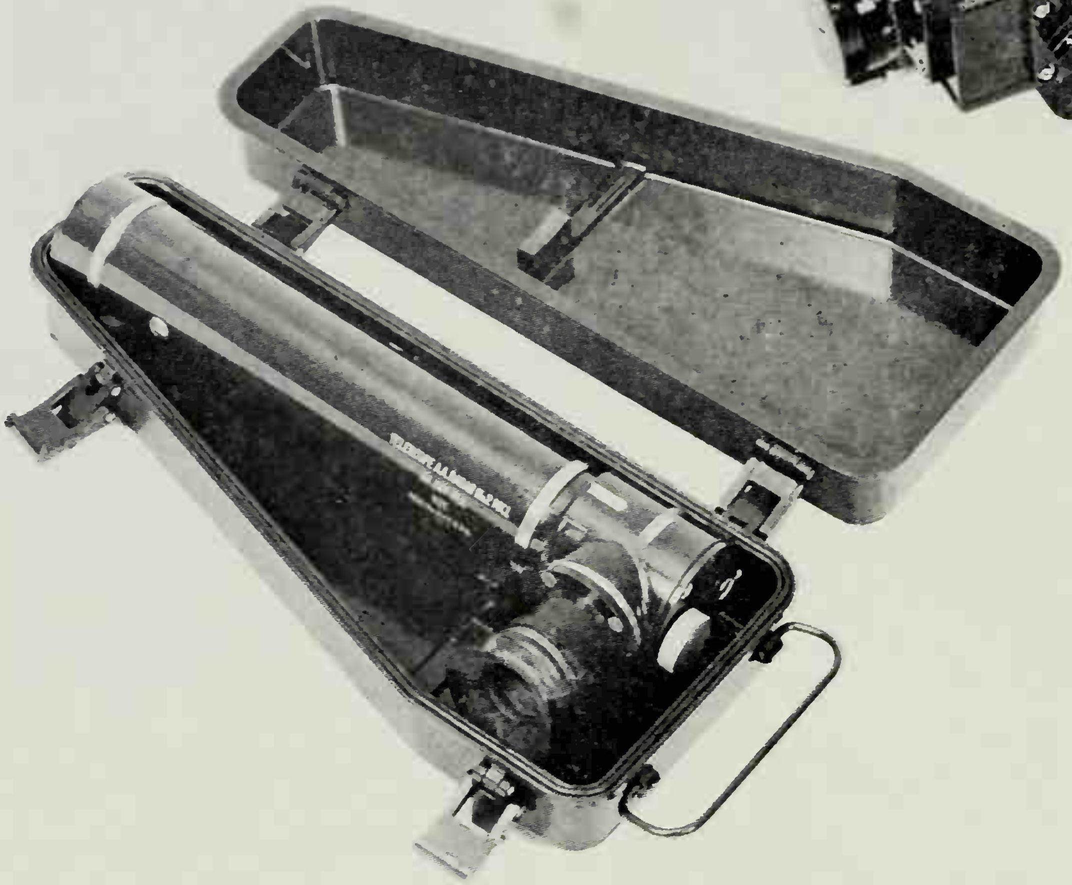




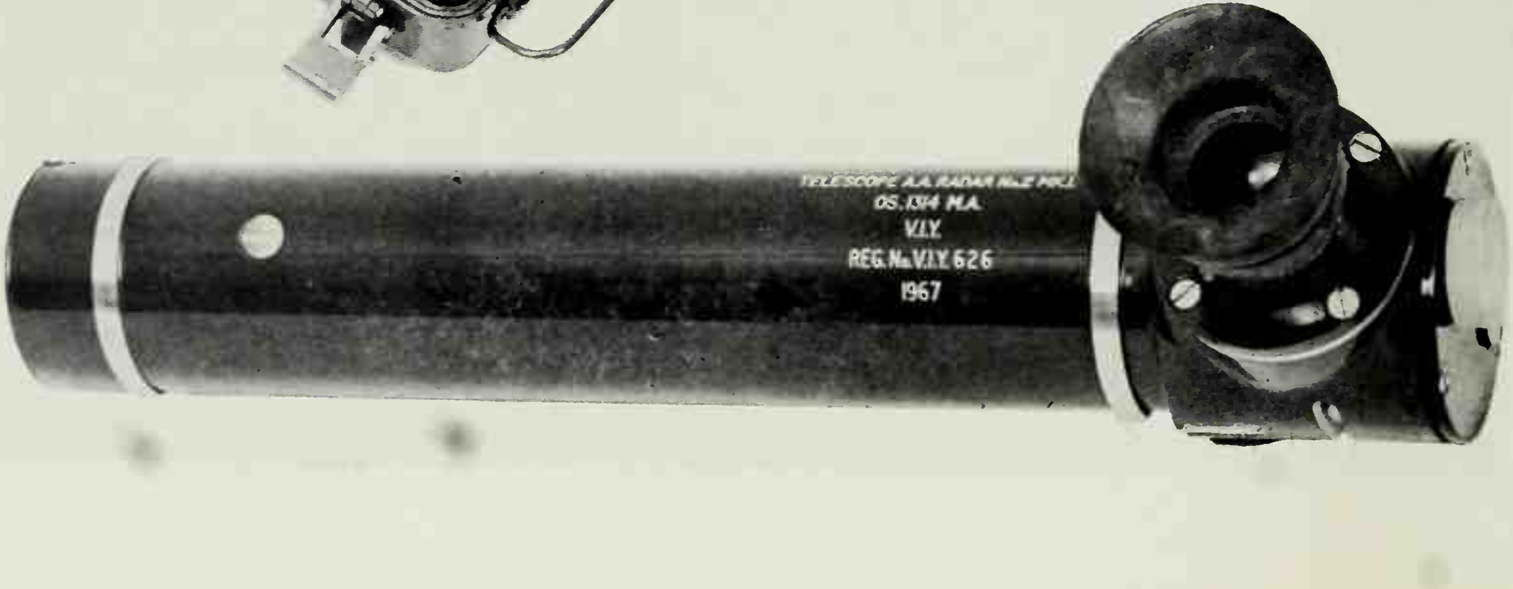
User's view (left) of the operational position of the Vickers periscopic sight No 30 Mk 1. A view of the aperture of the sighting head is shown at the right, while below is a view showing the adjusting knobs and illumination unit







Below is the Vickers AA radar elbow telescope No 2 Mk 1, while at the left it is shown in its aluminium carrying case


TELESCOPE A.A. RADAR No.2 Mk.1
OS. 1314 M.A.
V.I.Y.
REG. No V.I.Y. 626
1967

Sights and telescopes

General-purpose and radar alignment

Periscopic sight

The Vickers periscopic sight No 30 Mk 1 for armoured vehicles (NATO ref. No. 1240-99-200-7856) is a robust optical precision instrument. It is fitted as standard equipment on the Centurion tank.

Two adjusting knobs are provided which, set in mid-point reading, are capable of moving the graticule (in the 8 × system) at least 18mil to each side of this setting.

The sighting head is removable, being held by hinged latches which are operated easily through an eccentric hinge pin, notched at the end. Spare sighting heads can be supplied, each being interchangeable with the other.

Electric illumination is provided to the graticule.

The sight is located in a mounting by means of two side trunnions. Weight of the complete sight is 6·35kg (14lb).

Replacement parts can be supplied.

Optical characteristics

Telescope 8 × system		Infinity sight 1 ×	
Field of view	8°–30′	Field of view, vertical	9°–0′
Exit pupil diam.	4·45mm	Field of view, bino	11°–45′
EFL objective	249·68mm	Field of view, mono	45°–30′
EFL eyepiece	31·47mm		

Eyepiece focusing ±2½ dioptres

Alignment telescope

The Vickers AA radar elbow telescope No 2 Mk 1 (NATO ref. No. 1240-99-960-4670—OS 1314 MA) is a robust telescope suitable for the accurate alignment of radar systems. The body of the telescope is a one-piece component to ensure stability of the sight line and includes graticule illumination ports.

The telescope is supported by the two stainless steel end rings which are an integral part of the telescope body.

Weight of the telescope is 0·76kg (2lb 11oz), excluding the case.

A robust aluminium carrying case can be supplied if required.

Collimation

The optical axis is aligned to the mechanical axis to within ±30sec but a finer tolerance of ±15sec can be achieved if required. Although this telescope is set at infinity, it can be adjusted to suit customers' own requirements, ie to focus down to 18·28m (60ft) minimum.

A typical graticule pattern is a 20-min square sub-divided into four 10-min squares, with the horizontal and vertical cross lines divided into two-min intervals.

Other patterns can be produced to suit customers requirements.

Optical characteristics

Magnification ×7
Field of view 6 deg
Apparent field 42 deg
Exit pupil 3mm
Eye relief 21mm
Focusing adjustment ±3 dioptres

VICKERS LIMITED
Vickers Instruments
Haxby Road, York, YO3 7SD, England
Telephone: York 24112 Cables: Coordinate York

Vickers

Navigation system

Sperry vehicle navigator

The Sperry Navigator is an automatic and an entirely self-contained navigation system that continuously and accurately displays a vehicle's co-ordinates and heading, relieving the commander of the necessity to calculate his position constantly and freeing him for his other vital tactical tasks. No external reference is required; the system is therefore completely immune to enemy interference. The equipment is in world-wide general service with the British Army, has been sold in quantity to the Swedish Army and is on evaluation trials throughout the world.

Specification

COMPUTER

Overall accuracy
  Heading, magnetic version: better than 1 deg (18mils)
  Directional gyro version: better than 0·5 deg (10 mils)
  Position: better than 1% of the distance travelled
Environmental standard: meets all British Army requirements
Operating temperature range: –40°C to +60°C

Inputs
  1: distance run (from vehicle transmission)
  2: heading reference (magnetic detector or gyro)
  3: 24V dc magnetic system 1·5A, gyro system 1A plus gyro consumption (about 6A)

Outputs
  1: vehicle heading in mils
  2: vehicle position as an eight-figure map reference

Weight: 11·5kg (25lb)

Dimensions:
  277mm (10·88in) wide
  222mm (8·69in) high
  211mm (8·31in) deep

HEADING INPUT

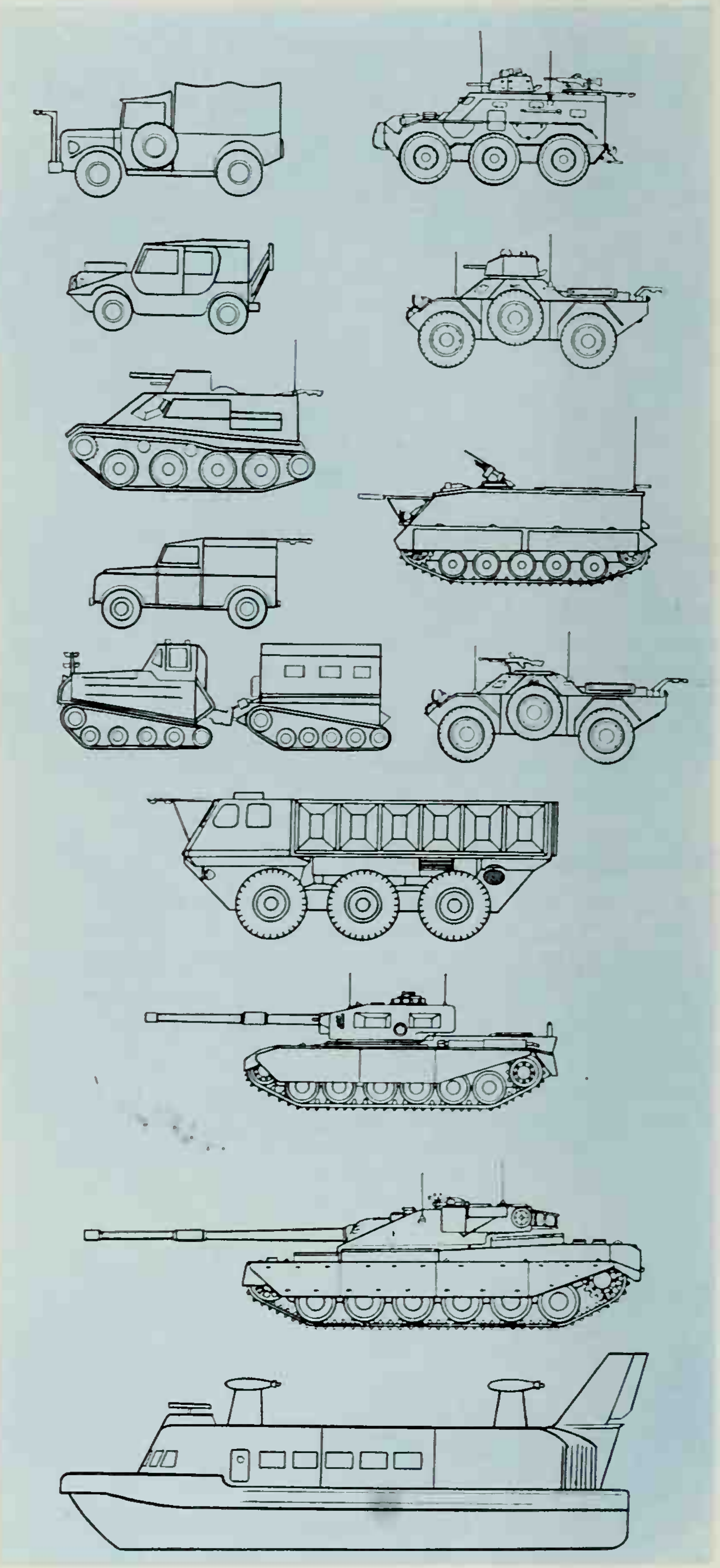
Magnetic detector unit
Weight: 0·91kg (2·2lb)
Dimensions: 120mm (4·75in) diameter
Boom: non-magnetic metal
System readiness time: immediate
System power consumption: 1·5A

or directional gyro
Input: 115V 3-phase 400Hz from 24V inverter
Weight: master unit 4·1kg (9lb)
Dimensions:
  184mm (7·25in) wide
  176mm (6·94in) high
  243mm (9·56in) deep
Power consumption: 40VA at 115V 3-phase 400Hz
Readiness time: better than 2min
Total drift rate: 15mils/h

or north-seeking gyro
The equipment can also accept inputs from a north-seeking gyroscope

MAP DISPLAY (optional)

A map display designed and developed by Sperry is available as an optional extra. It gives a continuous visual indication of the vehicle's position by the intersection of the two cursors driven by the computer. The vehicle commander can slip the map out of the display and take it with him for marking up at briefing meetings, orders groups, etc. No map preparation other than folding around a platen is required and the displayed area can be quickly changed. Any one of three scales can be selected. The map display meets Finabel military requirements.

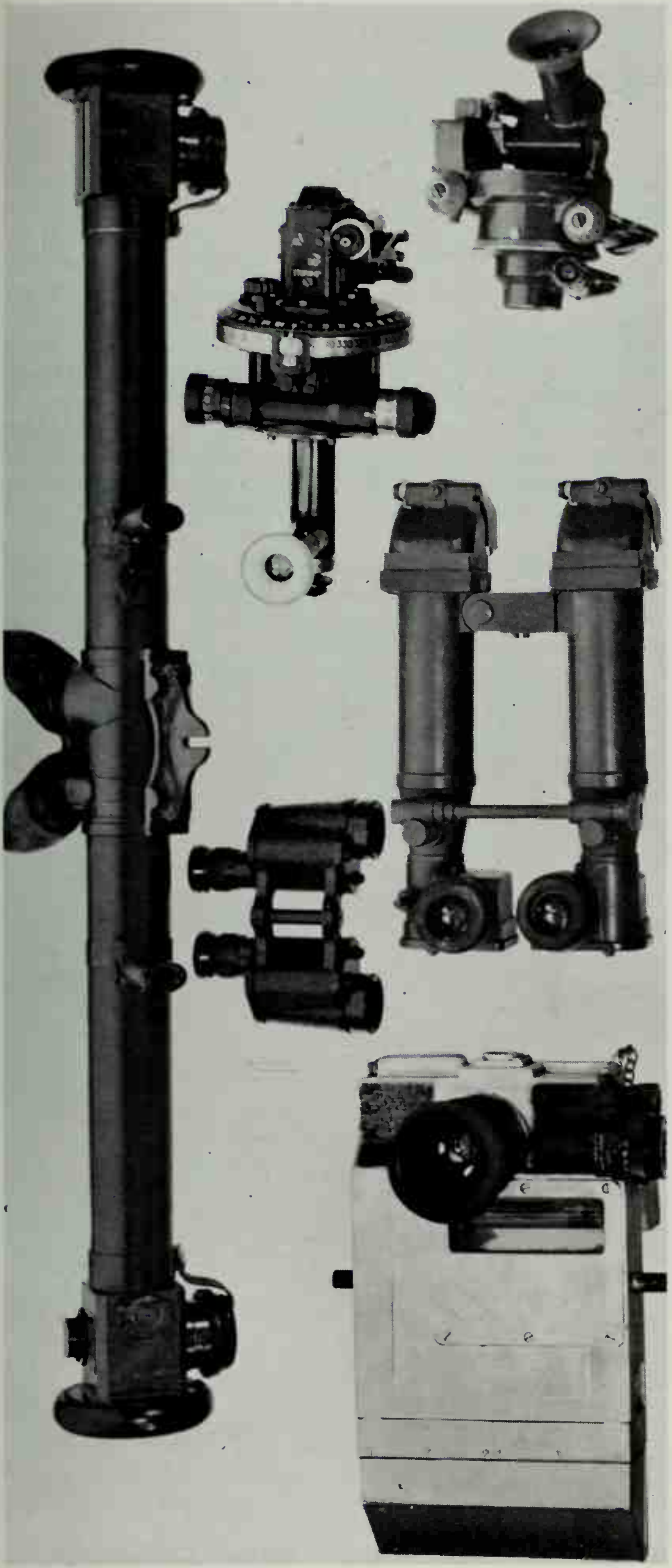


SPERRY GYROSCOPE DIVISION
Sperry Rand Limited
Downshire Way, Bracknell, Berkshire, RG12 1QL, England
Telephone: Bracknell 3222 Cables: Sperigyco Bracknell Telex: 84129

SPERRY

Optical systems

Sights, telescopes, periscopes



Defence Instruments (Optical) Ltd, in association with Charles Frank Ltd and Survey and General Instrument Co Ltd, carries a wide range of instruments and spares—current, obsolescent and obsolete. Included in our range are periscopic sights, stereoscopic telescopes for armoured fighting vehicles, tank periscopes, tank episcopes, rangefinders, artillery directors, dial sights, binoculars, etc. Since we have design, repair and manufacturing facilities, we can undertake to overhaul, modify or re-build. Catalogues can be supplied on request.

Details of our optical instruments and equipment for photogrammetry and surveying will be found elsewhere in this Catalogue.

Overhead projector for personnel training
In conjunction with our associate company, we are in the process of developing a combined overhead projector and episcope. Data are available on request.

DEFENCE INSTRUMENTS (OPTICAL) LTD
145 Queen Street, Glasgow C1, Scotland
Telephone: 041-221 6666 Cables: Binocam Glasgow

Gun sight

with automatic digital elevation read-out

This automatic digital elevation (ADE) sight is based on a gravity sensing device which provides a horizontal datum. A sensor is fitted to the elevating mass of a gun and its output is relayed to digital readouts. As the gun is elevated or depressed its elevation is continuously displayed on a counter. This obviates presetting of the elevation and laying by bubble and lends itself to automation. It improves the accuracy as it measures the actual elevation of the elevating mass, its readout can be set to 0·25 mil and the layer's task is vastly simplified. It can be fitted swiftly and simply to existing guns.

The sensing head is standard equipment and is designed to be interchangeable with any other head unit and to be mounted on any gun. The head, which has a cross-levelling capability, is fixed to the elevating mass. No accurate aligning of the sensing unit to the gun barrel is necessary as this is done electronically when sight testing.

The electronic unit carries all the electronics necessary for the operation of the sight. It can be mounted in any convenient place on the gun or in the turret. The miniaturised components, using silicon transistors and integrated circuits, are mounted on a number of plug-in printed circuit boards which facilitate maintenance as they are easily and rapidly replaceable. The mean time between failures (MTBF) is more than 2000 hours.

The display unit is a standard design and is common to all equipments. It incorporates two pairs of light indicators. The first pair shows whether the detector head cross axis is level and, if not, in which direction it is inclined. The second pair indicates to the layer whether he is elevating or depressing within the speed range of the sight.

Specification

Dimensions
Electronic unit: 230 × 190 × 115 mm
Digital display unit: 210 × 115 × 85 mm
Sensing head: 200 × 190 × 190 mm

Weight
Electronic unit: 3·6 kg
Digital display unit: 1·4 kg
Sensing head: 8·5 kg

Power requirements: 24 V 1 A max
Angular range: ±1600 mils (90°)

Automatic reciprocating sight bracket

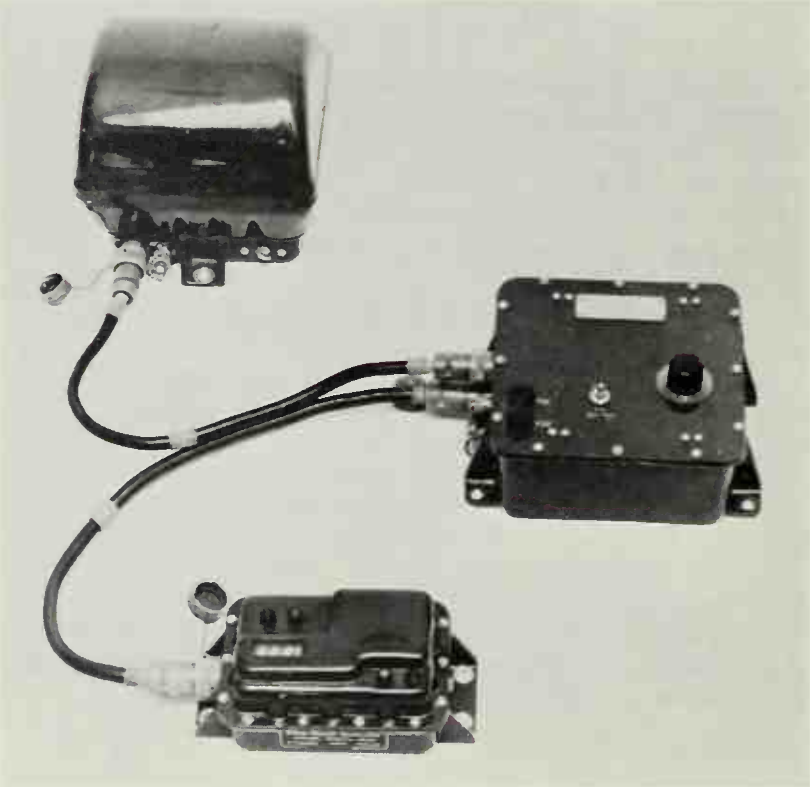
This carries the azimuth sight, automatically maintains it vertically and offsets the sight line when the gun is elevated over tilted trunnions. The elevation is supplied to it by the ADE sight. Laying is considerably simplified and is speeded up. In the event of breakdown or enemy action reversion can be made to the manual mode as at present.

The carrier can be fitted to any gun and can be adapted for any azimuth sight. Being unconnected mechanically with the elevating mass it can be mounted anywhere on the traversing mass.

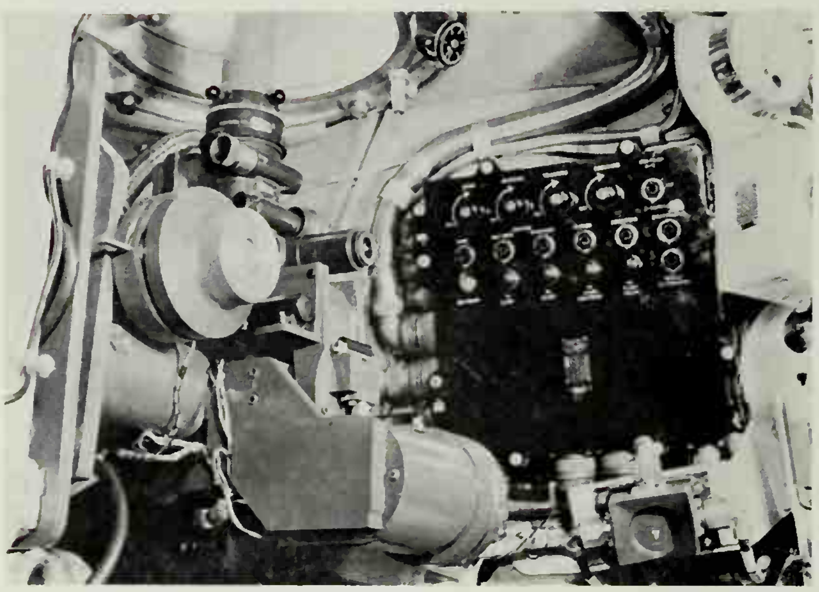
Specification

Dimensions: 410 × 380 × 355 mm
Weight: 27·2 kg
Power requirements: 24 V 2 A max
Tilt compensation: 180 mils R + L (10°)

These units, together with a data link between gun and command post (field computing equipment), can form the basis of an automatic sighting system.



The ADE sight comprising sensing head, switchbox and digital display unit



Automatic reciprocating sight bracket installed in an Abbot self-propelled gun

BRITISH AIRCRAFT CORPORATION LIMITED
Precision Products Group
Six Hills Way, Stevenage, Herts, England
Telephone: Stevenage 2422 Cables: Britair Stevenage Telex: 82125

Gyro-stabilised sight

Avimo-Ferranti series for vehicle-borne weapons

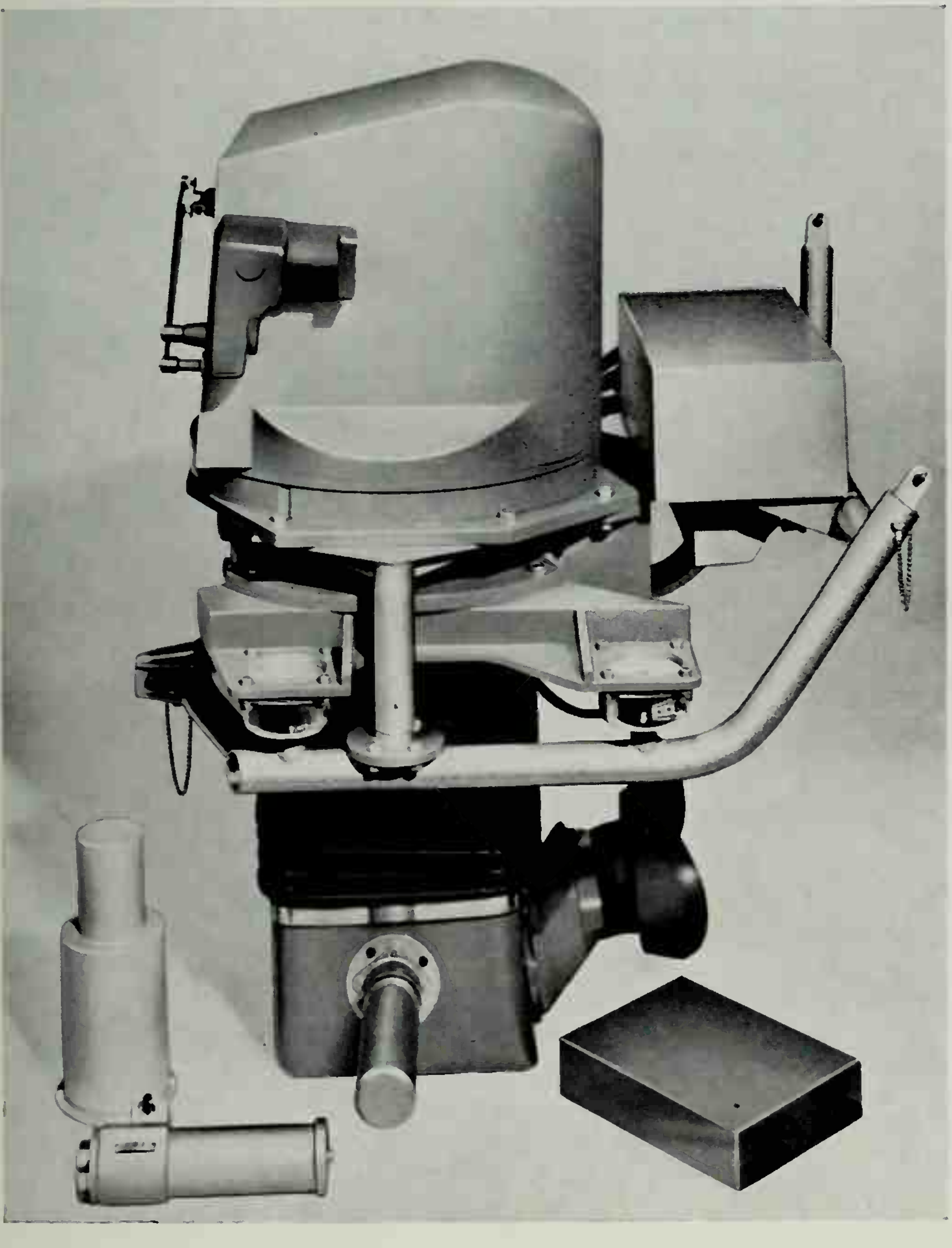
The Avimo-Ferranti stabilised sighting system Type AF.120 is adaptable to vehicle-borne weapon systems. In these applications sighting can be effected on the move. Anti-vibration mountings smooth out inherent high-frequency low-amplitude vibrations and an integral gyroscope stabilises the sightline against larger disturbances. Two magnifications of the viewed stabilised image are provided: low magnification with a large field of view and high magnification with a small field of view. A thumb-operated switch on the tracking control is used to obtain the required magnification.

An electrically driven gyroscope is directly coupled to the top mirror of a periscopic arrangement stabilising the sightline against pitch and yaw motions. Any movement in roll only causes apparent rotation of the image.

In any periscopic mirror arrangement rotation of one mirror about a vertical axis causes an apparent tilt of the viewed horizon. The Avimo-Ferranti sight incorporates an automatic image-tilt correction prism which maintains the viewed horizon correctly orientated throughout the yaw motions of the sightline. Since the mirror is electrically controlled, a variety of tracking control configuration and positions is available.

The bi-ocular eye-pieces remain in a forward-looking direction at all times. In both axes, azimuth and elevation, the rate at which the mirror scans is related to the movement made of the tracking control handle. The scan rate is thus directly controlled by the operator. The servo-driven rotating head on the top of the sight protects the top mirror from buffeting by external forces and ensures that an optically acceptable window is provided at the correct angle to receive the top mirror image. The window is fitted with an electrically driven wiper with washing and de-misting facilities.

The sight is collapsible for easy storage.



Specification

Magnification: × 2·5; × 10
Fields of view: >20° (× 2·5); >5° (× 10)
Deflection of the field of view: ±60° azimuth; 60° elevation (total)
Tracking rates: azimuth up to 40°/sec; elevation up to 6°/sec
Total exploration field with stationary eye-piece: azimuth 140°; elevation 80°
Eyepiece: bi-ocular (5 mm exit pupil)
Interpupillary distance: 56 to 72 mm
Independent eyepiece focusing: –5 to +2 dioptres
Vertical adjustments: over 165 mm (6·5 in) distance

The type AF.120 sight can be fitted with a simulator spot injection unit which, together with an analogue unit located at a convenient position within a helicopter, provides the necessary simulation for operator training. Additionally, where operator training performance is required to be monitored, a camera can be fitted which films simulated engagements as well as live firings.

The simulated missile flight is represented by a light spot projected on the face of a cathode-ray tube within the spot injection unit. The light spot is injected into the operator eyepiece and therefore into the field of view. The camera input is so arranged that it can record the field of view with the injected spot or real firing.

The spot-injection unit is mounted on the lower optical assembly. The voltage inputs to drive this unit are provided by a small analogue and power supply unit. The initial conditions on the missile analogue are set up by the instructor. The analogue unit controls launch attitude and missile launch relative to aircraft speed, together with range, etc. The analogue is designed on the modular principle so that different missile simulations can be set up by changing plug-in board components. The size of the analogue and power supply unit is 317 × 127 × 203 mm (12·5 × 5 × 8 in)

The illustration shows the Avimo-Ferranti Type AF.120 gyro-stabilised sight assembly with the mounting frame for installation in Scout and Wasp helicopters. Components of the spot-injection unit for the simulator are also shown

FERRANTI LIMITED
Aircraft Equipment Department
South Hill Park, Easthampstead, Bracknell, Berkshire, England
Telephone: Bracknell 4202 Telex: 84117

FERRANTI

Periscopes and cupolas

for all-round vision in fighting vehicles

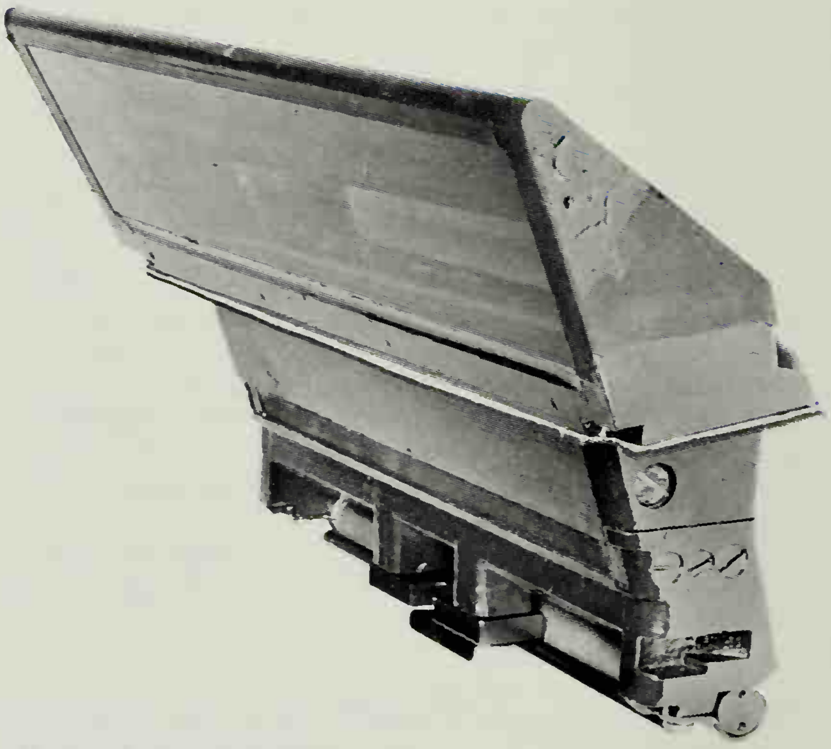
Helio periscopes and cupolas for fighting vehicles give personnel maximum vision coupled with safety.

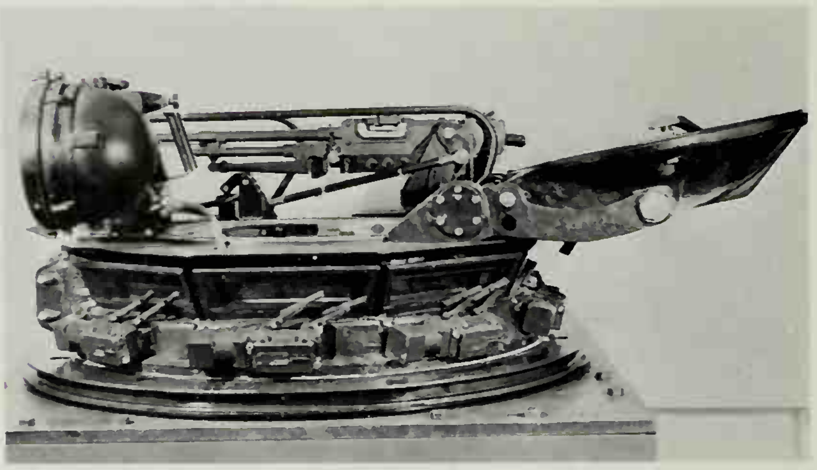
The periscope illustrated is the one now replacing the original instruments fitted to the cupola of the Chieftain tank and versions of it are under development for the Scorpion, Fox and other British fighting vehicles. Prototypes for M.109, M.113, Leopard, AMX series and several other fighting vehicles are also under development.

These instruments, which can be produced to fit most types of military vehicles, are non-reflecting and of advanced design embodying several advantages:

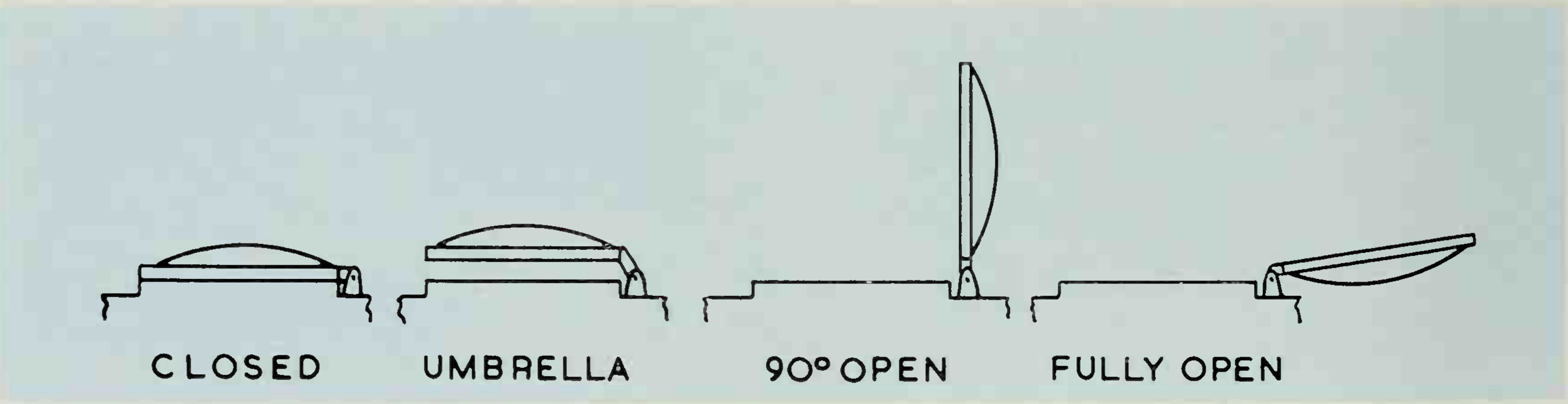
1) Immunity from detection by reflected light from the sun, a searchlight or an infra-red source.
2) Immunity to the crew from shattering glass, because the two prisms comprising the periscope are isolated so that if the upper prism is damaged in action the lower prism protects the user's eyes.
3) Synthetic rubber encapsulation affords protection to the periscope and the user, allows easy withdrawal for replacement and provides a sealed instrument.
4) The periscope is fully desiccated and nitrogen-filled.
5) Collimation of line-of-sight during manufacture ensures that when used as a nest of periscopes a common horizon is obtained without further adjustment.
6) The instrument remains fully operational over the temperature range –40°C to +80°C and can withstand air transportation in an unpressurised cabin at 11 200 m (37 000 ft) without damage and an external water head of 4·6 m (15 ft) without leakage into the periscope or vehicle.
7) Better light transmission compared with a plastics type periscope results in far greater efficiency under threshold conditions of dawn and dusk.
8) Prisms are flush-faced for ease of cleaning and the periscope is suitable for mechanical wiping.
9) In place of the usual coating of black paint a layer of black glass is fused to the matt surfaces of prisms to ensure permanent optical contact.

The illustration on the right shows part of the ring of No 40 Mk 2 periscopes giving all-round vision in the No 17 cupola, designed and produced by Helio in conjunction with MVEE for a Chieftain variant. Indicated diagramatically below are the four hatch positions possible on this cupola. Changing from one position to another takes only a few seconds.


No 40 Mk 2 periscope


No 17 cupola

Below: the four hatch positions of the No 17 cupola



We shall be glad to carry out design studies on any aspect of sighting periscopes or cupolas within the scope of our facilities.

A Division of United Scientific Holdings Limited
HELIO MIRROR COMPANY LIMITED
Crabtree Manorway, Belvedere, Kent, England
Telephone: Erith 32142   Cables: Scodil London W1   Telex: 265403

AMETS

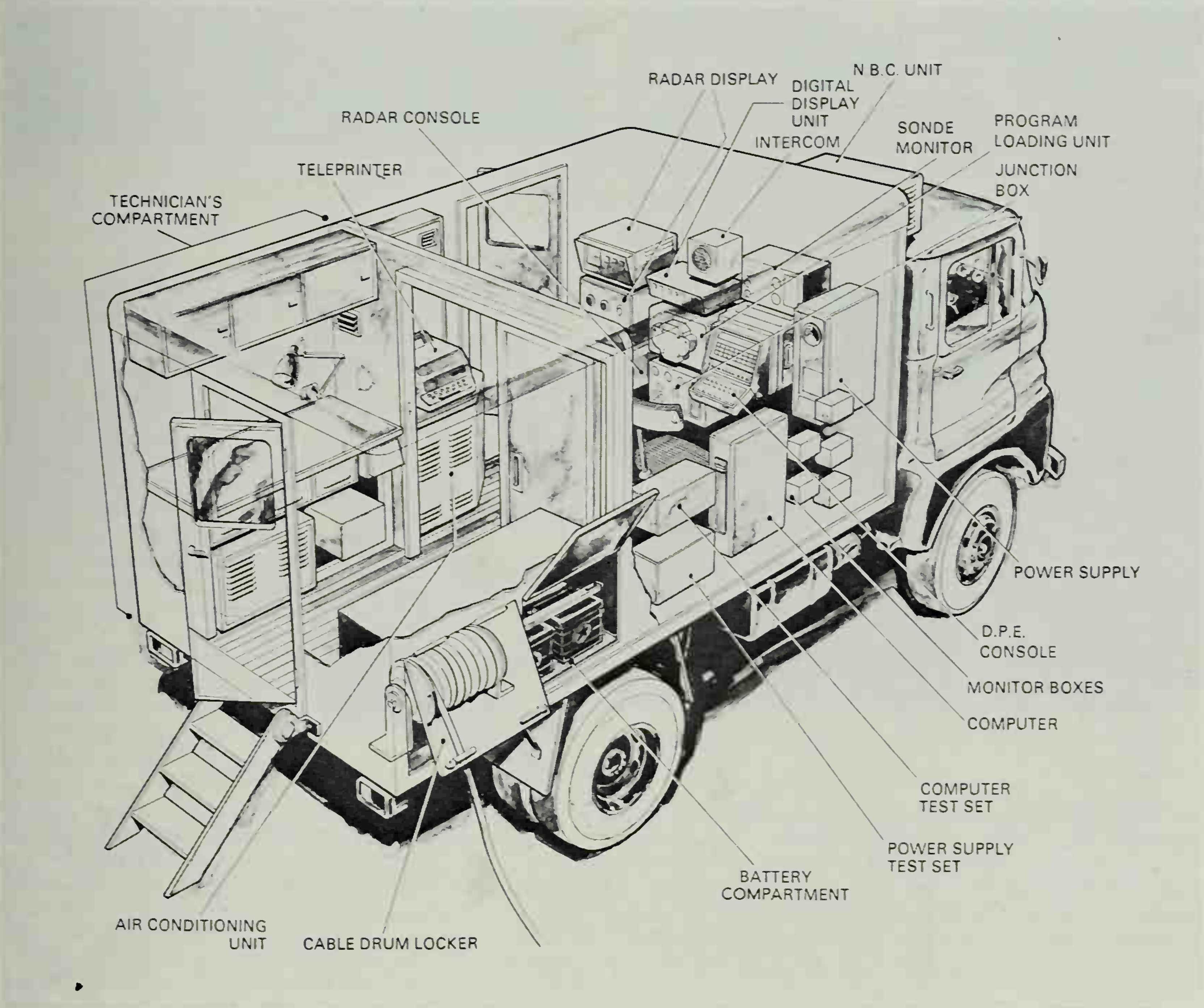
artillery meteorological survey

AMETS is a self-contained, computer-based, mobile meteorological station designed for the British Army, for obtaining and processing information on atmospheric conditions. The system comprises conventional radiosonde launching, receiving and radar tracking equipment with a specially designed data-processing system.

The data-processing system is capable of producing accurate meteorological information almost instantaneously in immediately usable form as the balloon ascends. There are no delays while the information is processed manually, no highly trained operators and no chance of human error. The equipment has been designed and built to military specifications.

This knowledge of computer-based data processing can be applied to many other aspects of military management. It has particular application where command and control decisions have to be taken rapidly, and where all relevant information has to be called up and presented to the commander or staff cell.

The elimination of human errors, coupled with immediate access to information, give commanders and staff great flexibility and speed of response to amend and generate new plans.


RADAR DISPLAY
N.B.C. UNIT
DIGITAL DISPLAY UNIT
INTERCOM
RADAR CONSOLE
SONDE MONITOR
PROGRAM LOADING UNIT
TELEPRINTER
JUNCTION BOX
TECHNICIAN'S COMPARTMENT
POWER SUPPLY
D.P.E. CONSOLE
MONITOR BOXES
COMPUTER
COMPUTER TEST SET
POWER SUPPLY TEST SET
BATTERY COMPARTMENT
AIR CONDITIONING UNIT
CABLE DRUM LOCKER

Cut-away view of a typical AMETS system for providing commanders with virtually instantaneous information on meteorological conditions. The entire computer-based system can be mounted on one general-purpose vehicle

A GEC-Marconi Electronics Company

MARCONI SPACE AND DEFENCE SYSTEMS LTD

Military Division

Chobham Road, Frimley, Camberley, Surrey, England

Telephone: Camberley 63311 Cables: Elliotauto Camberley Telex: 85289

Gun control equipment

for all types of fighting vehicle

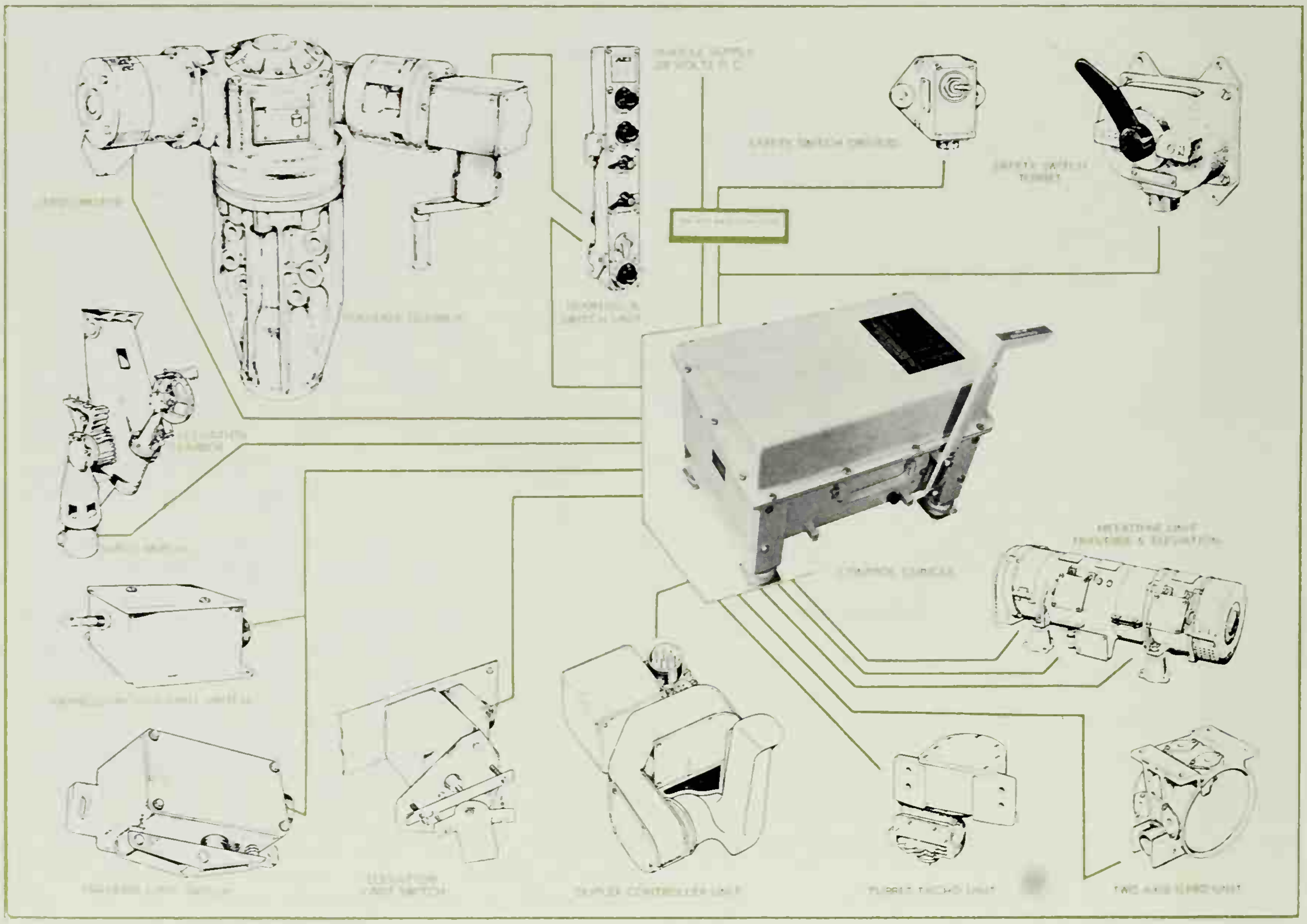
Gun stabilisation improves the battle performance of a tank by ensuring faster target engagement and a higher first-round hit probability while firing on the move. The all-electric system fitted to the Centurion and Chieftain tanks has proved to be the most suitable for fighting vehicles.

The EC517 gun control and stabilisation equipment is an all-electric system. The equipment uses all the latest techniques to provide a gun-laying and stabilisation performance which has been proved under battle conditions. The system has been selected for the Vickers main battle tank and enquiries are invited from companies or countries who wish to improve the performance of their present tanks or who require new equipment for projects under development.

Centurion tank on manoeuvres

Centurion modernisation

Centurion tank gun-control equipment may be modified using the EC517 system. This not only secures the advantage of improved performance, but also increases reliability, simplifies operation and reduces procurement problems. The equipment can be fitted to replace the FV/GCE No 1 equipment during a normal rework period at a base workshop, no change to the Centurion vehicle being necessary.



EC517 gun control equipment

A GEC-Marconi Electronics Company
MARCONI RADAR SYSTEMS LIMITED
AEI Control Engineering Department
New Parks, Leicester, LE3 1UF, England
Telephone: Leicester 871331 Cables: Assocelect Leicester Telex: 34551

Infra-red sights

Portable and vehicle-mounted

Infra-red sights for armoured vehicles

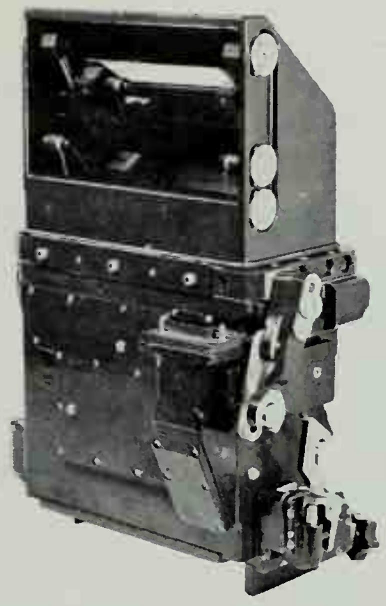
These infra-red periscopes are either for permanent fitting in tanks and armoured vehicles or for substitution for the normal daylight periscopes to provide night vision. They are of the latest binocular pattern and are made in two types, one for use at the gunner's position, the other for use by the commander.

The majority of parts are identical to both types but whereas the gunner's sight has an illuminated graticule and is rigidly aligned to the gun, the commander's sight has a field of view which is adjustable in elevation for observing near or far objects.

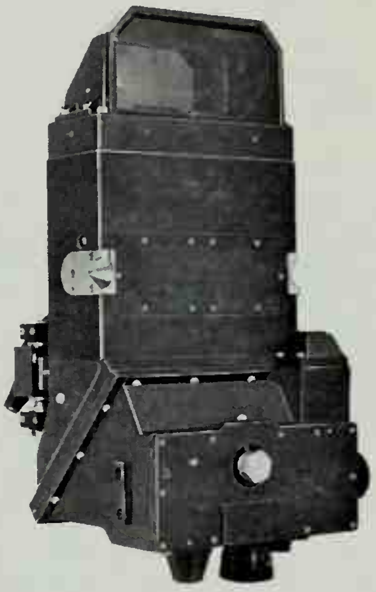
The sights are operated from the 24 V electrical system of the vehicle. They are of extremely rugged construction and completely waterproof and are not affected by gunfire or bumps and vibrations.

Engineering facilities can be provided for fitting them into any make of tank or vehicle.

Projector/searchlights for use with the sights are supplied as separate units to meet specific requirements.



Commander's sight



Gunner's sight

Specification

Field of view: 13°
Depth of focus: 30 m (100 ft) to infinity
Eyepiece setting: ± 2 dioptre
Power supply: 24 V tank supply (negative or positive earth)
Temperature range: –40°C +70°C
Magnification: 2·8 ×
Tubes and spares: details on request

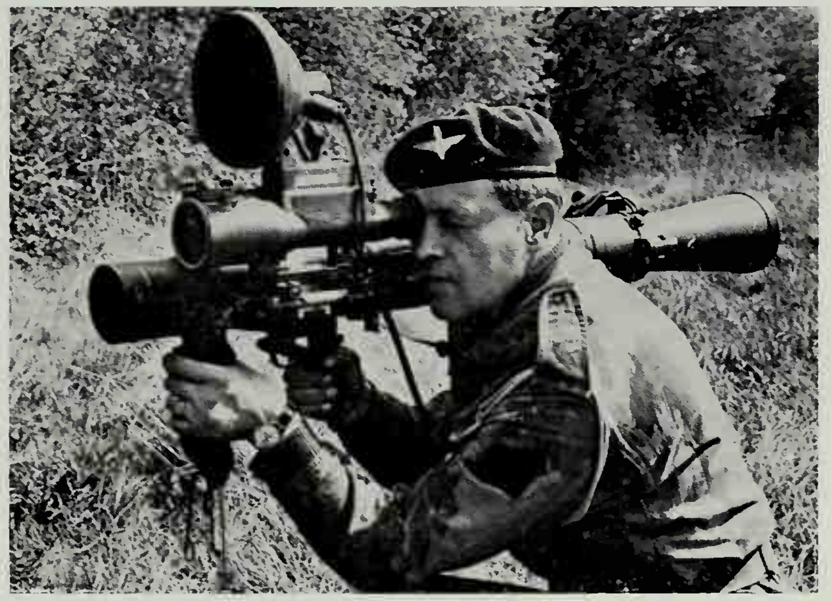
Infra-red weapon sight for infantry

This is a portable infra-red system used by infantry for night combat, consisting of an infra-red projector and monocular telescope combined in a single light-weight unit.

It may be used with any make of rifle, machine-gun or anti-tank weapon. Special brackets enable the unit to be quickly attached or detached from the weapon. Adjustments are provided for accurate alignment of the illuminated graticule with the weapon sights, and for optimum positioning of the projector.

The unit is operated from a 6 V portable battery which provides six hours of continuous use. This is regarded as adequate for a typical one-night operation. The battery is carried in a webbing pouch and is rechargeable. All electrical parts are suitably enclosed and the unit is panclimatic and immersible.

It conforms to the relevant NATO standards and to the specifications of the defence forces of most countries.



Muzzle bore sights

Muzzle bore sights are optical devices for checking and adjusting the accuracy of gun-sights.

The standard muzzle bore sight is a right-angled telescope for fitting in the muzzle of the gun to enable it to be accurately trained on a target.

The gun-sight, or the graticule of the gunner's periscope, is then independently adjusted to the target, which brings it into exact alignment with the gun barrel. With this device the aiming accuracy can thus be checked at any time without going on to a firing range or expending ammunition.

The special muzzle bore sight also includes a reference telescope for inserting in the breech end of the gun barrel which enables the ballistic performance of the gun to be measured with great accuracy.

Muzzle bore sights can be provided with adaptors suitable for a number of different sizes of barrel, including 76 mm, 105 mm, 120 mm, a 20 pounder and 5·5 and 6·5 in.

These instruments were designed in consultation with the British Military Vehicles and Engineering Establishment, are fully approved by the Ministry of Defence and are in service with the British Army and many other armies throughout the world.

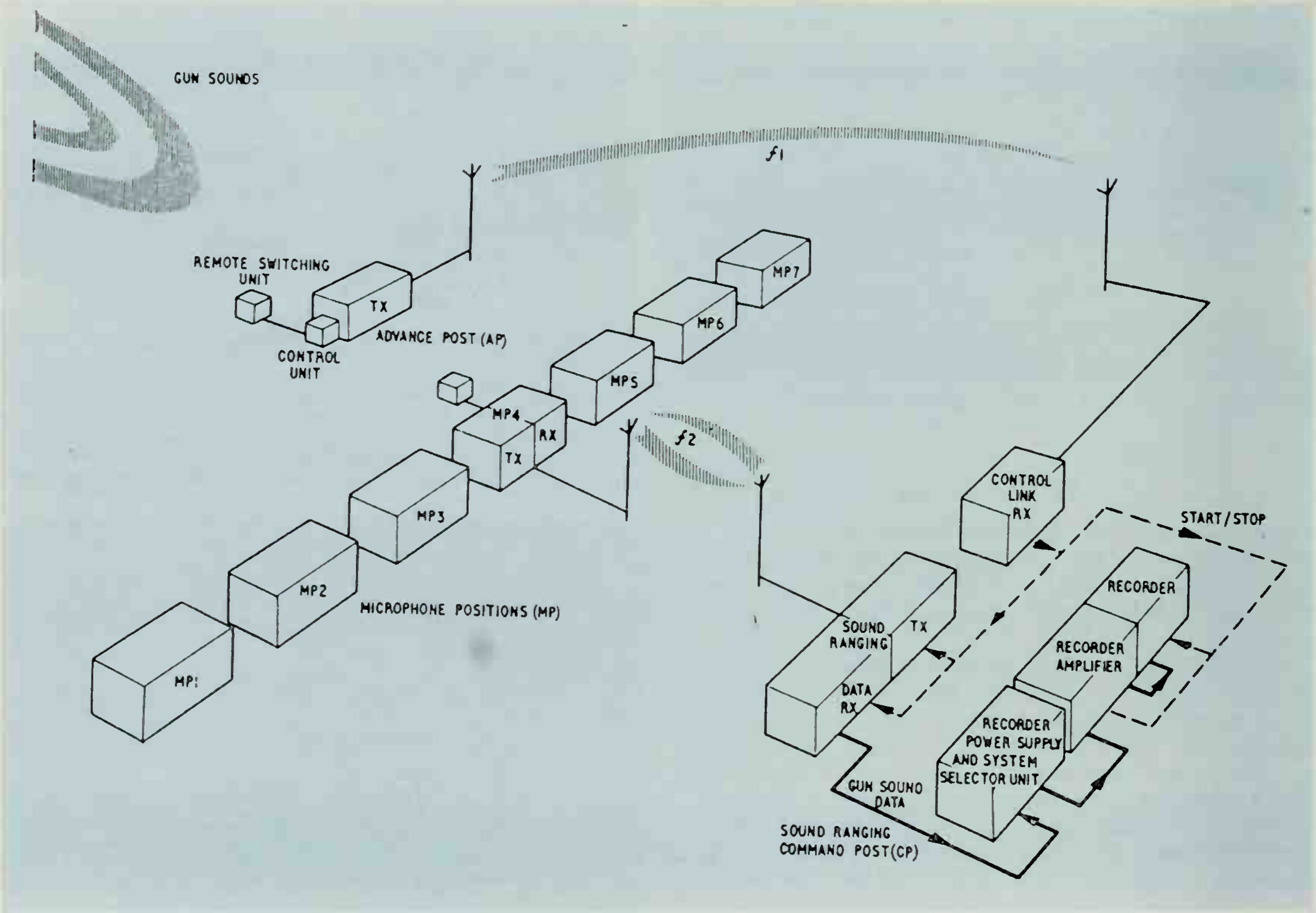
THE MEL EQUIPMENT COMPANY LIMITED
Manor Royal, Crawley, Sussex, England
Telephone: Crawley 28787 Telex: 87267

MEL

Sound ranging system

for locating artillery positions by radio

Analysis has shown that eighty percent of the battlefield casualties in the Second World War were caused by artillery fire. As a result much effort was made to destroy or neutralise enemy artillery by counter-bombardment. However, before counter-bombardment fire can be brought to bear, the enemy weapon must first be located. With this in mind the Plessey gun sound ranging system No 2 Mk 1 has been developed.


GUN SOUNDS
f1
REMOTE SWITCHING UNIT
TX
ADVANCE POST (AP)
CONTROL UNIT
MP7
MP6
MP5
MP4
RX
TX
f2
MP3
MP2
MP1
MICROPHONE POSITIONS (MP)
CONTROL LINK RX
START/STOP
RECORDER
RECORDER AMPLIFIER
SOUND RANGING
TX
DATA RX
RECORDER POWER SUPPLY AND SYSTEM SELECTOR UNIT
GUN SOUND DATA
SOUND RANGING COMMAND POST(CP)

Sound ranging is a means of locating a sound source, based on the assumption that sound travels uniformly from its source at a known velocity.

A typical sound ranging base consists of seven microphones, connected by a data transmission link to a data recording and processing centre. To achieve an accurate location, the position of each of the microphones must be fixed by precise survey, and the time intervals must be corrected for non-standard atmospheric conditions.

An observer is deployed in the forward area at an advanced post. It is his task to listen to the enemy artillery fire and to switch the system on when he wishes it to record. He also provides additional information such as estimated type and calibre of weapon, number of rounds fired and so on. This information is relayed to the data recording and processing centre by radio. Two advanced posts are normally deployed.

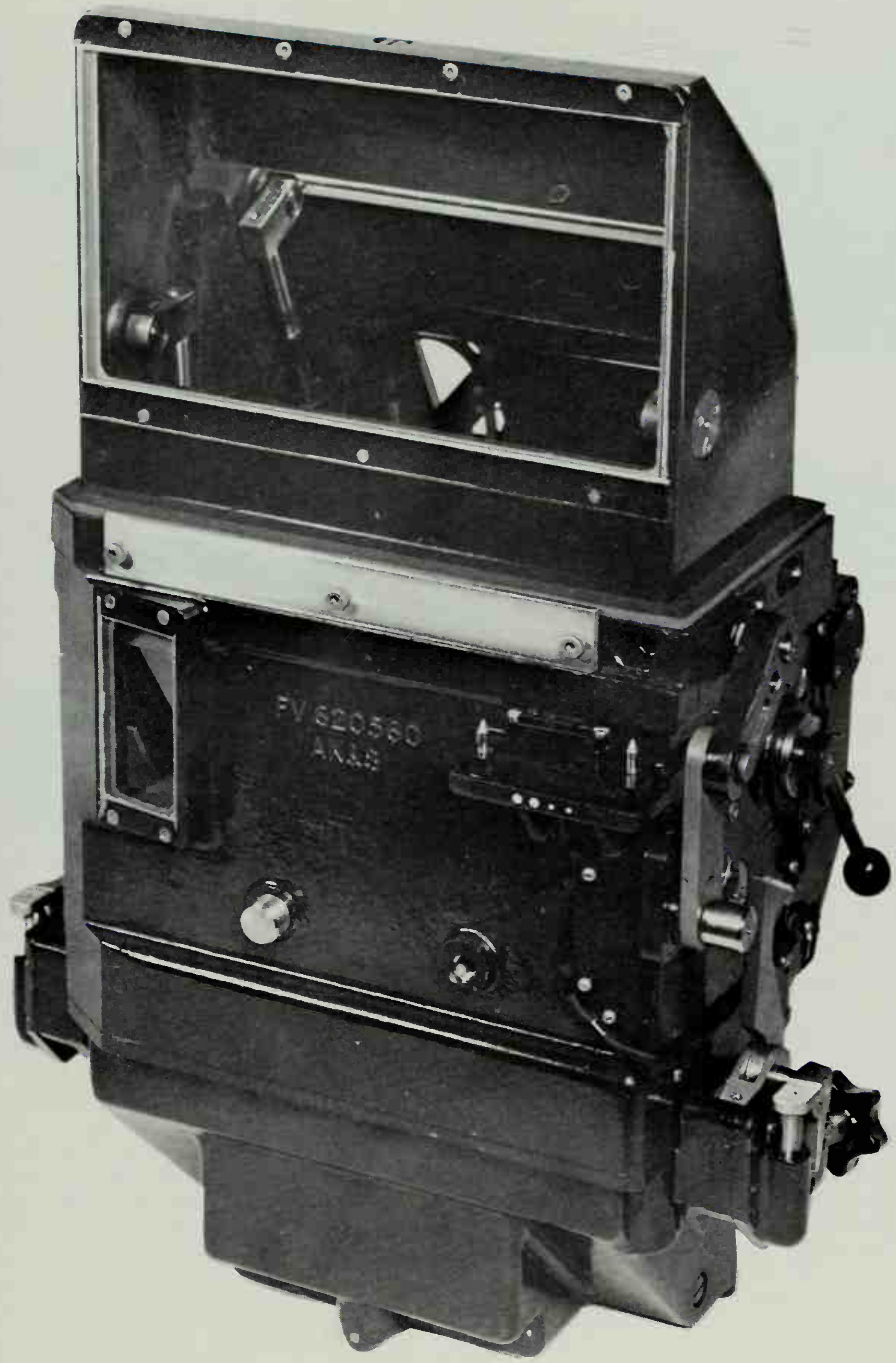
Sound ranging has three applications:

1. The location of a hostile weapon (passive role)
2. The adjustment of counter-bombardment fire by sound comparison (active role)
3. Self-help procedures:
    a. Assuming surveyed microphone data are not available:
        (1) The calculation of microphone co-ordinates (at reduced accuracy) by locating surveyed detonations
        (2) The calculation of relative microphone co-ordinates, for adjustment of fire procedures, by locating the shellburst of a co-operating fire unit (base registration)
    b. The calculation of meteorological correction data, in the absence of a standard sound ranging meteorological message, by locating surveyed detonations.

THE PLESSEY COMPANY LIMITED
Electronics Group
Vicarage Lane, Ilford, Essex, England
Telephone: 01-478 3040 Telex: 23166

Optical equipment

for military use



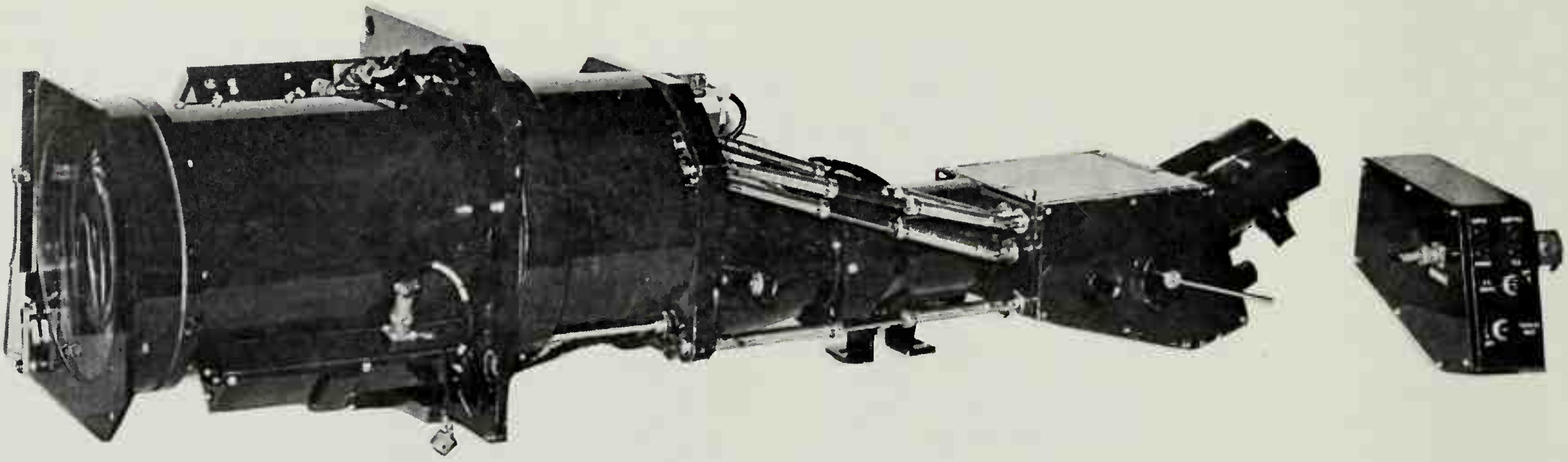
Tank sights, periscopic sights, rifle sights, services binoculars, gun-mounted binoculars, paralleloscopes

Rank Kershaw manufactures a wide range of sights, binoculars and bore telescopes for all aspects of military use and to specific requirements, as well as a standard range of aerial reconnaissance lenses, opto-mechanical systems and fibre optic products.

RANK PRECISION INDUSTRIES LIMITED
Rank Kershaw Industrial Division
200 Harehills Lane, Leeds, LS8 5QS, England
Telephone: Leeds 624601 Cables: Science Leeds Telex: 55162

Passive night sight

for armoured fighting vehicles



Fox image intensifier night sight

These image intensifier night sights are designed for use mounted in the turret of fighting vehicles such as the Fox and Scorpion. They have two roles: firstly they enable the gunner to locate, identify and engage targets at night without recourse to artificial lighting, and secondly they may be used for general surveillance.

The sights contain two objectives mounted one within the other. The outer one, which is selected when the sight is to be used in its primary role, has a magnification of ×5·8 (Fox), ×6·5 (Scorpion). The inner one, which is selected when the sight is to be used for surveillance, has a magnification of ×1·6 (Fox), ×1·8 (Scorpion).

A flap shutter isolates the low-magnification objective when the high-magnification objective is in use and an iris diaphragm isolates the high-magnification objective when the low-magnification objective is selected.

The iris diaphragm may also be used to reduce the light-gathering power of the high-magnification objective to suit the brightness of the target.

A flash shutter, operated electrically from the gun firing button, protects the image intensifier tube from the effects of gun muzzle flash.

Either a setting graticule or a ballistic graticule may be illuminated when the high-magnification objective is in use. The former is selected when the sight is to be correlated with the gun and is used in conjunction with a bore sight. The latter is used for laying the gun.

The graticules are adjustable in tangential elevation and azimuth and are ganged together so that the ballistic graticule becomes aligned when the setting graticule is being adjusted.

A circular graticule may be illuminated when the low-magnification objective is in use and this defines that portion of the field which would be covered if the high-magnification objective were to be selected.

The illumination of all the graticules may be adjusted to suit the brightness of the target.

The exposed window of the objective, which is a plane window, is cleared by a wiper and washer and the eyepieces are prevented from fogging by thermostatically controlled eyepiece heaters.

RANK PRECISION INDUSTRIES LIMITED
Metrology Division
Langston Road, Debden Industrial Estate, Loughton, Essex, England
Telephone: 01-508 5522 Cables: Survey Loughton Telex: 23855

1966
1967
1968

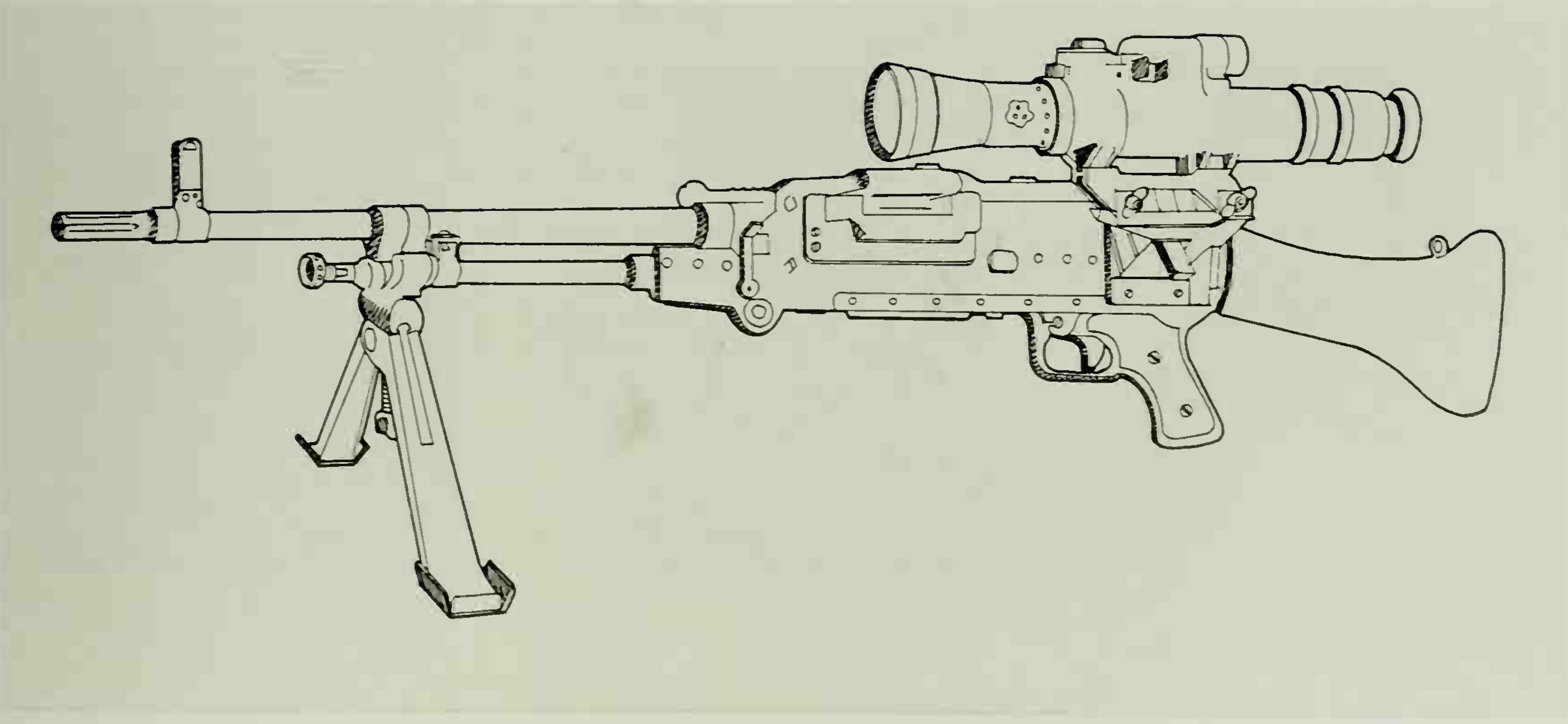
Individual weapon sight

L1A1 for direct fire and surveillance

The L1A1 individual weapon sight was originally designed to be used with infantry weapons for engagement of targets at night. It relies solely on natural moonlight or starlight illumination of the target, even under darkest jungle conditions. The sight is self-contained and consists of three integrated units: the primary optical system (which can be focused from 10 metres to infinity), the main body (which incorporates the graticule, intensifier tube, oscillator and power supply), and the magnifier. The graticule is adjustable in elevation and azimuth for weapon alignment. The incorporated battery provides about 100 hours' intermittent operation and can be readily replaced in darkness without breaking the seal of the complete unit. The sight carries a device enabling it to be boresighted to the weapon during daylight and this also enables the sight to be used in dawn and dusk conditions. Brackets are available to enable the sight to be mounted on various weapons. The sight has been thoroughly tested by the British Ministry of Defence and has its full approval.

Above: Individual weapon sight L1A1

Below: weapon sight mounted on general-purpose machine gun



RANK PRECISION INDUSTRIES LIMITED
Metrology Division
Langston Road, Debden Industrial Estate, Loughton, Essex, England
Telephone: 01-508 5522 Cables: Survey Loughton Telex: 23855

1966
1967
1968

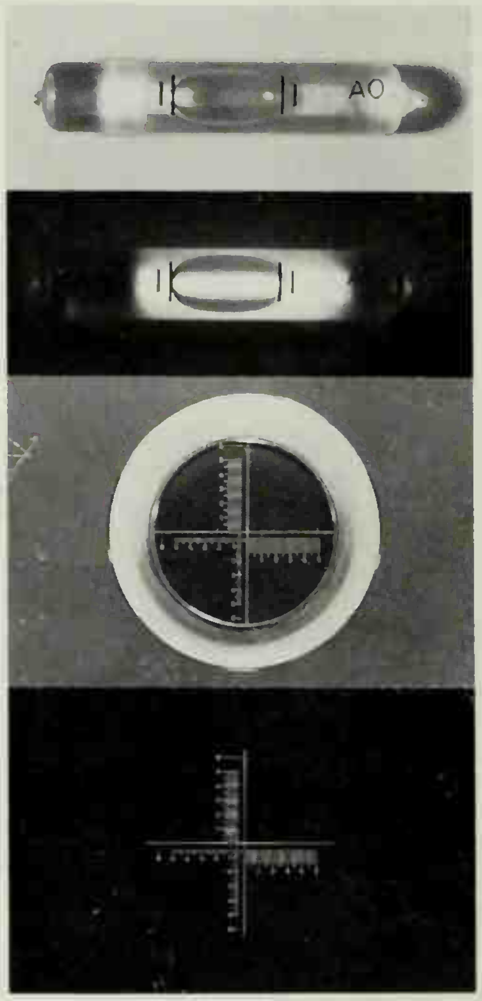
Night viewing aids

Betalights (Trilux lamps) for military equipment

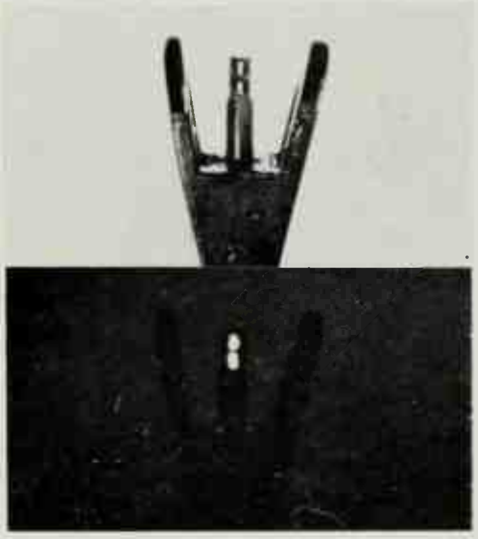
Betalights are low-level light sources that require no power supply, batteries or electrical connections. Betalights are available in a variety of shapes, sizes and a range of colours: they do not require maintenance and have a useful life generally in excess of the equipment in which they are used.

Betalights have already been adopted for a wide range of military uses. Some of them are shown below, while details of others are readily available on request.

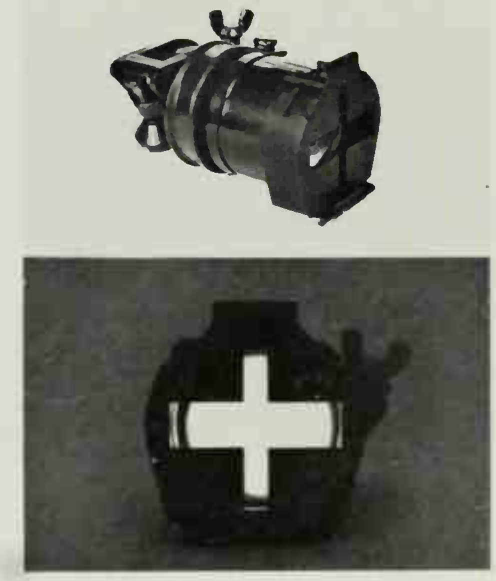
The British and other armies have already shown that Betalights increase mobility and improve efficiency.



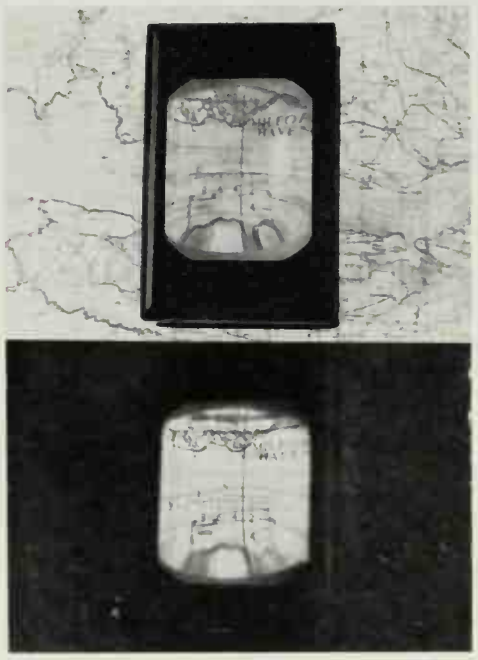
Betalight illuminated level bubbles and graticules are available for a wide range of sighting equipment. The components are easily assembled without the added complication of considering wiring problems.



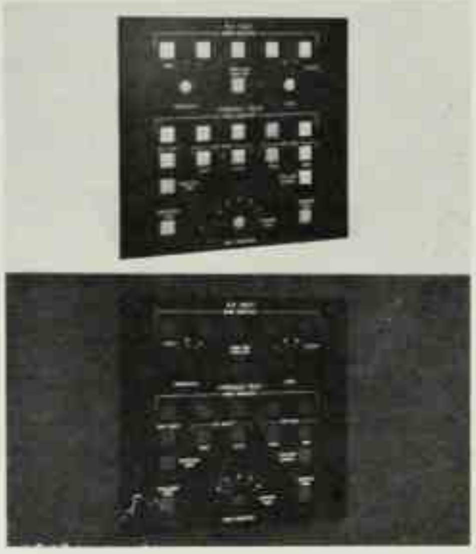
Betalight illuminated rifle foresights have improved night firing accuracy by an average of 70 percent. The level of illumination has been chosen to give adequate rear visibility for the soldier firing without being visible from long distances. It cannot be seen from the front.



The Betalight illuminated aiming post lamp is a single 227 g (8 oz) unit which can be carried in the pocket. It contrasts very favourably with previous methods which required a power supply or batteries.



Betalight illuminated map and message readers largely eliminate the risk of security lapses caused by torches and similar devices.



Panel illumination by Betalights gives absolute reliability without maintenance and a life that is usually longer than that of the equipment itself. No heat is generated, no battery is required and there is no need for any wiring connections.

The Stanley Mk 4 prismatic compass has Betalight illumination on the dial, index ring and sighting points. The level of illumination is superior to conventional luminous paint, making readings more accurate and greatly reducing eye strain.

SAUNDERS-ROE DEVELOPMENTS LIMITED
North Hyde Road, Hayes, Middlesex, England
Telephone: 01-573 3800 Cables: Airily London Telex: 22121

SRDL

1970

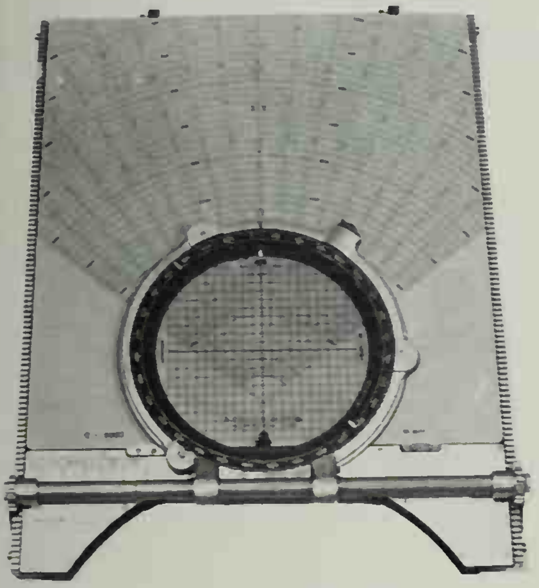
Fire-control aids

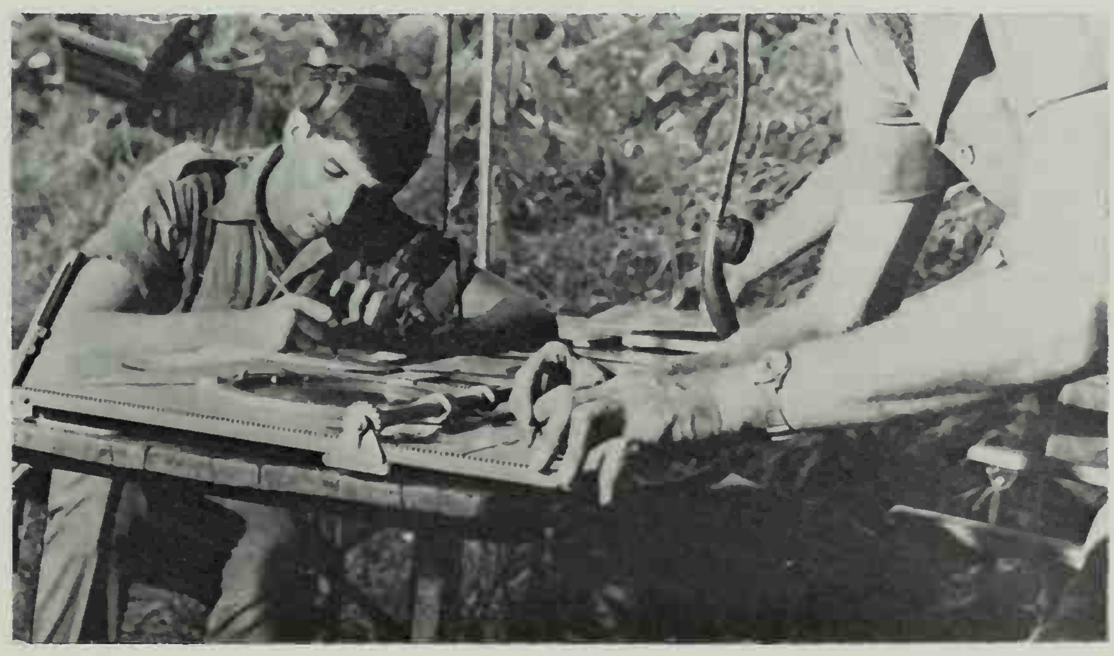
for ground forces

A wide range of instruments is available from United Scientific Instruments Ltd to aid in the control of artillery fire, two typical units being shown here. Details of other instruments and equipment are available on request.

Light fire-control plotter FBA No 1 Mk 1

This fire-control plotter provides quick and accurate solutions of the various problems concerning the deduction of map data for artillery and mortar fire. It can be used successfully with almost any type of field artillery equipment. The plotter operates over a complete arc of 6400 mils (360°) about the gun position, and out to a range of 20 000 metres, at a scale of 1:12 500. It has been designed in a lightweight version which allows for easy air-portability, and measures only 580 × 460 mm (23 × 18 in).





Gun rule and fuze indicator, for NATO 105 mm pack howitzer

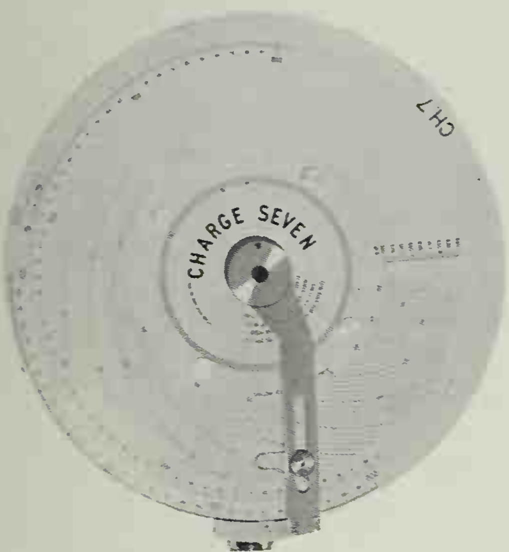
The gun rule and fuze indicator illustrated is specifically designed for use with the 105 mm pack howitzer, now standard equipment with several NATO armies.

Use of the gun rule gives two important advantages:

a) Simplification of command post drills. The command post need only deduce the map azimuth and range to the target, without having to look up the quadrant elevation, and

b) More accurate shooting. The individual muzzle velocities of the different guns can be set on their respective gun rules; this will concentrate the fire of the guns.

Use of the fuze indicator allows quick and accurate calculation of the fuze setting for mechanical time fuzes, to achieve an airburst over the target. It allows the observation post officer to adjust range and height of burst separately.



A Division of United Scientific Holdings Ltd

UNITED SCIENTIFIC INSTRUMENTS LTD

Kirkman House, 54a Tottenham Court Road, London, W1P 0BQ, England

Telephone: 01-636 5905 Cables: Scodil London W1 Telex: 265403

Small arms day/night sight

This sight increases the effectiveness of small arms operation particularly during low light level conditions because of its very high light transmission.

The sight has a graticule illuminated by a trithium light source which is easily adjustable. It has been designed to meet stringent military specifications.

Different mounts are available which incorporate adjustments for zeroing in azimuth and elevation.

Magnification: ×4
Objective aperture: 28 mm
Exit pupil dia: 7 mm
Focus: fixed

Field of view: 7°
Light transmission: 65%
Length: 290 mm
Weight: 330 grammes

Avimo Ltd
Herbert Street, Taunton, Somerset, England
Telephone: Taunton 81071
Cables: Avimo Taunton
Telex: 46126

Small portable radar torch: SPRAT

This is a hand-held ground-surveillance radar which is primarily intended for military use.

The SPRAT was designed by the Royal Radar Establishment (Battlefield Surveillance Section), who also made the prototypes. It is now being manufactured and sold by Avimo Ltd under a licence from the British Ministry of Technology.

SPRAT is a clutter-locked pulse doppler radar. The composite signal reflected from the target is received and processed to detect target movement, which is denoted by an audible doppler note in the earphones.

Range is up to 1100 metres for a vehicle and 500 metres for a man with a ± 30 metre accuracy range discrimination of 50 metres.

Avimo Ltd
Herbert Street, Taunton, Somerset England
Telephone: Taunton 81071
Cables: Avimo Taunton
Telex: 46126

Vehicle and airborne optics, military optics

We design, develop and manufacture optical systems for a variety of weapons, ranging from self-propelled anti-aircraft guns to anti-tank guided weapons.

The vehicle-borne optics are of the periscopic-type and can be binocular or monocular. The monoculars can have split-field presentations (two magnifications in one eye piece or a flip change to two separate magnifications). The monoculars for anti-tank guided weapons are of low magnifications with high fields of view. This is necessary for acquiring missiles early in their flight and bringing them on to the line of sight.

Avimo has also designed periscopes for aircraft use, for the examination of stores (underwing or inside the aircraft) and for drift measurements.

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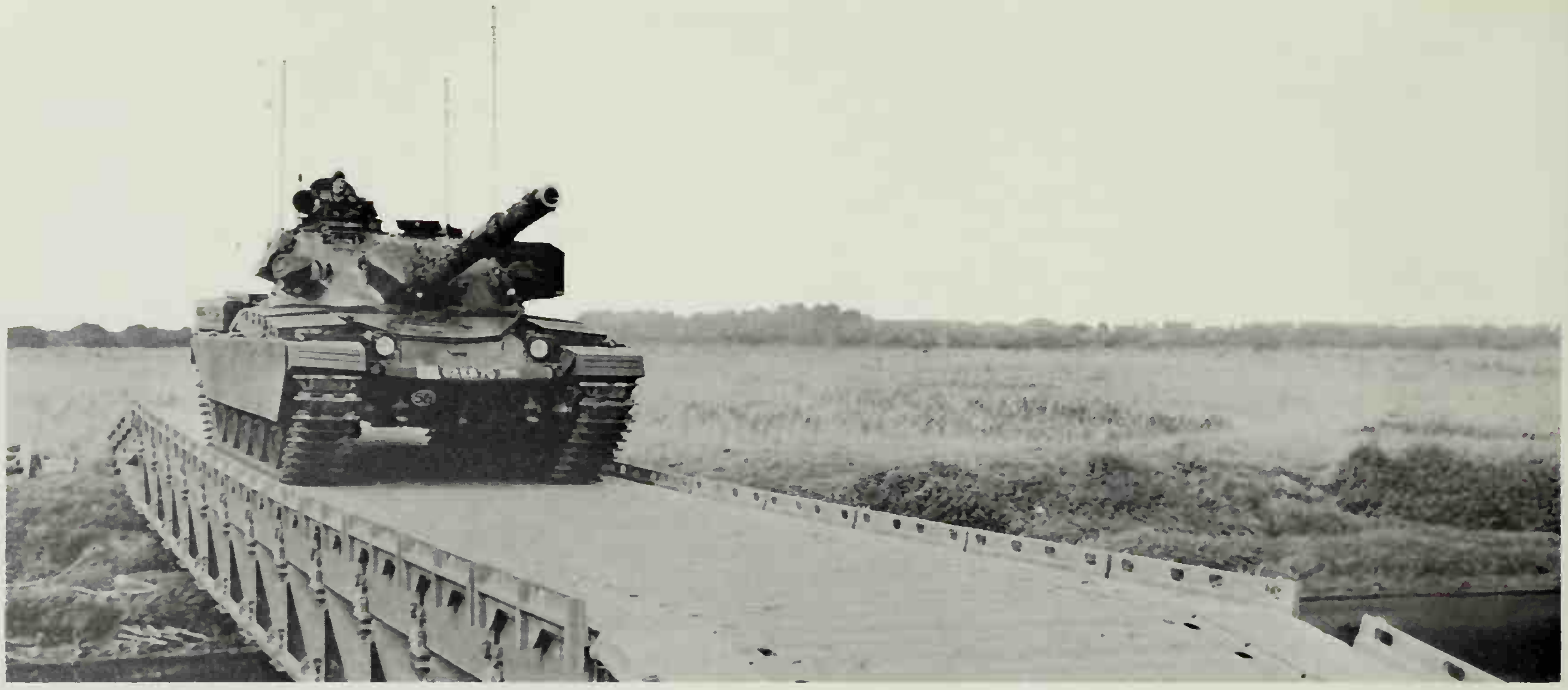
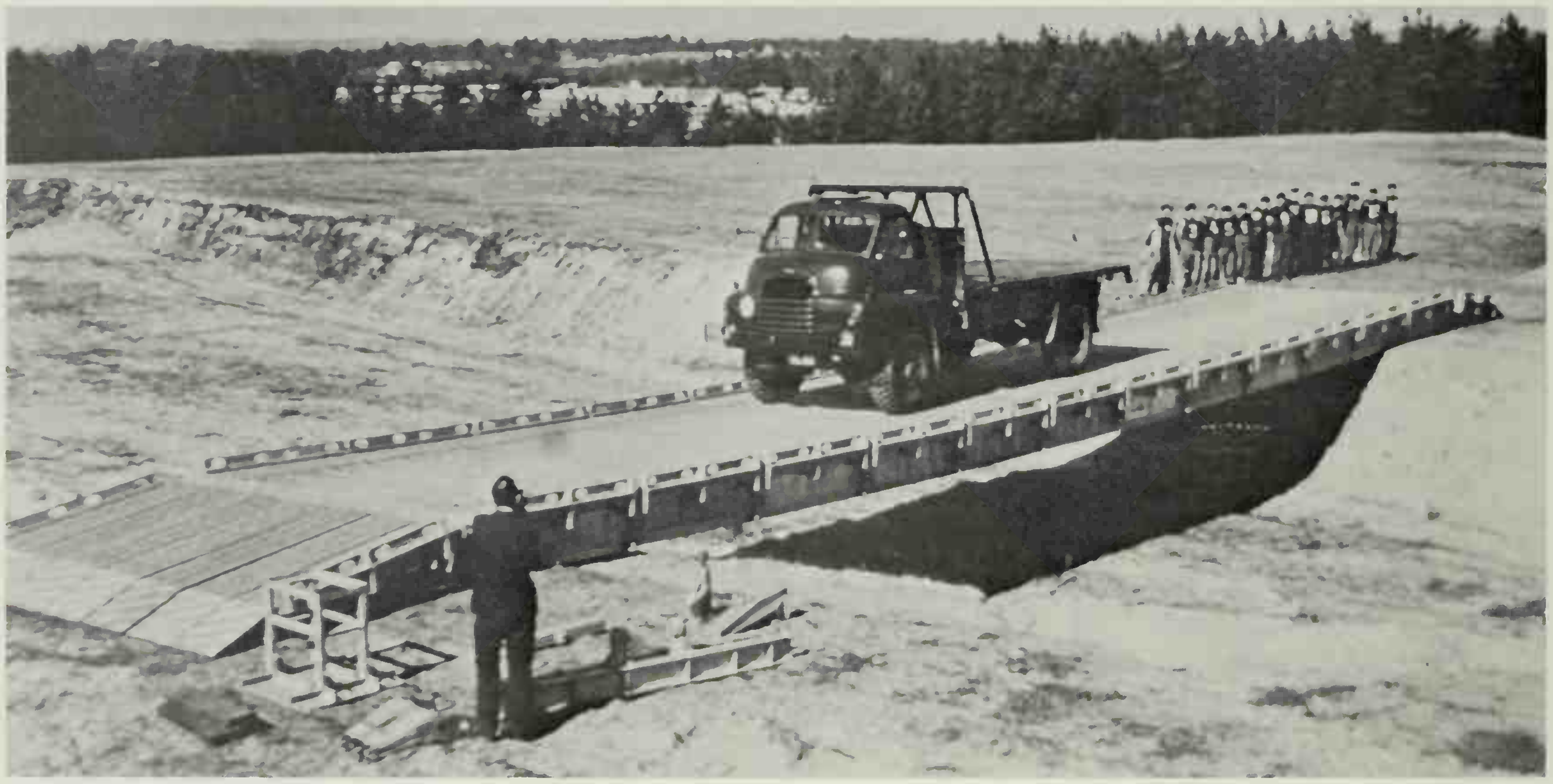
Section 11

Engineer equipment

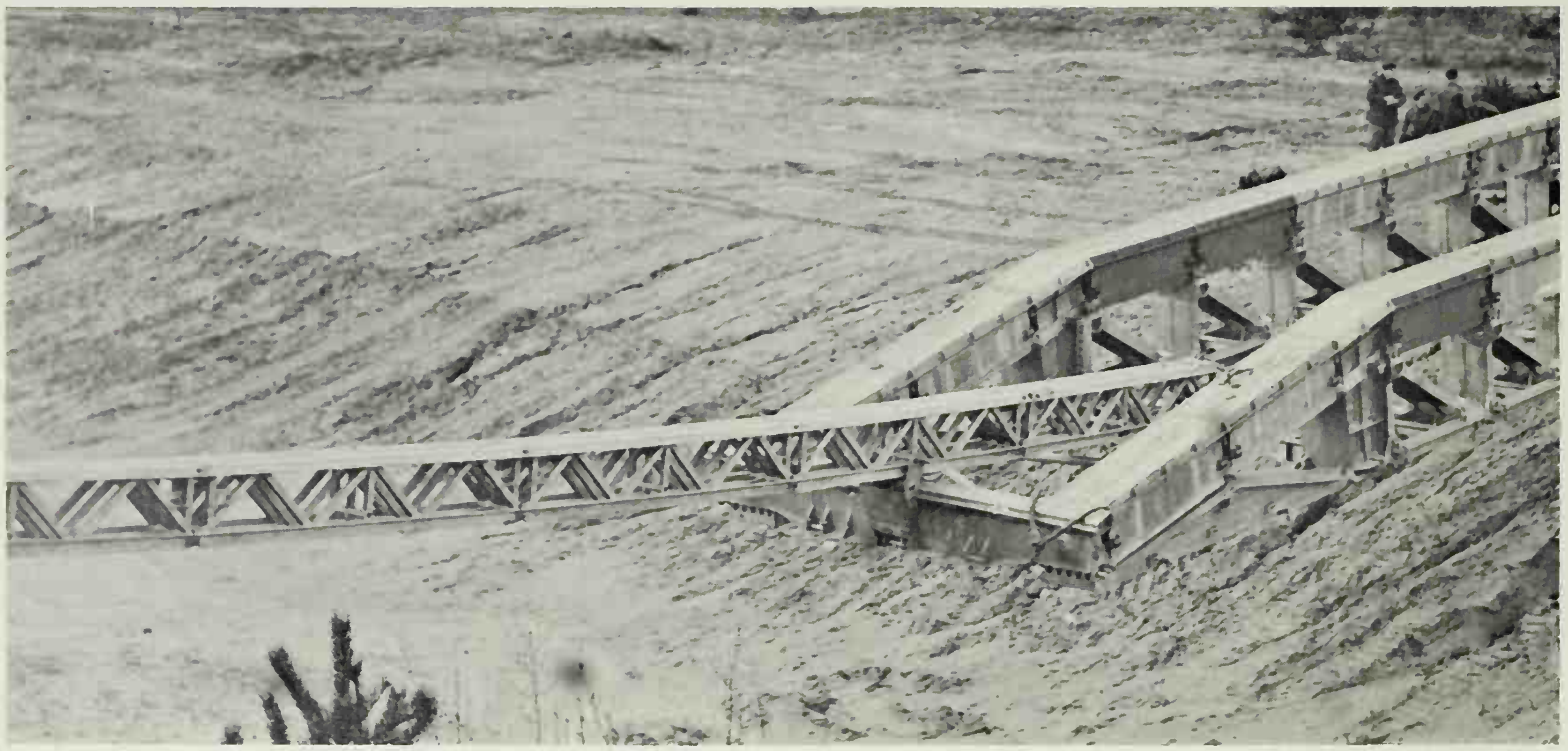


Tank on double-storey medium girder bridge (see table on opposite page for spans)



Truck on single-storey bridge (see table on opposite page for spans)

A bridge is launched, undecked, with a central launching nose of suitable length



Medium girder bridges

single- and double-storey

The medium girder bridge can be assembled either as a single- or a double-storey construction, of varying lengths. It will carry Class 60 loads over gaps of up to 30·5 metres (100ft), but longer spans of lower load classes can be built. When span junction posts and other accessories are available, it will be possible to build multi-span bridges of any length on fixed or floating piers.

The basic unit is a light alloy box section top panel, 183cm (6ft) in length. Sections can be rapidly joined together to make a pair of long girders which form the load-carrying members of the bridge. A light alloy decking is then laid between them to give a roadway 4 metres (13ft 2in) wide.

For long spans and heavy loads the side girders can be deepened by the addition of triangular bottom panels, which are equally easy to handle and assemble. Very long bridges can be made up of successive spans joined together by span junction posts and supported on piers or pontoons.

Kerb sections can be fitted along the edges of the bridge. Where required, footwalks and handrails are available.

Ramp units give access at the ends of the bridge which may be placed directly on the ground. There is no need to rest the bridge on grillages.

The bridge can be assembled, in 1·8-metre (6ft) increments up to the longest span of 48·7 metres (160ft), by 24 men and a NCO. No cranes are needed and no component requires more than six men to lift it.

Assembly: 1½ to 2 hours
In use: 1 hour
Dismantling: 2 to 2½ hours
Total: 4½ to 5½ hours (by night)

The medium girder bridge can be built, used and dismantled in about half the time that would be needed simply to build a comparable bridge of the same span and load class, that is to say of 30·5 metres (100ft) Class 60. It takes about 30 per cent longer at night.

This high speed is achieved by keeping the bridge and all its components to the minimum weight, by minimising the time required to unload stores, and by providing pin-hole aligning devices to ensure quick and easy insertion of panel pins.

When a single- or double-storey girder bridge has been assembled it is launched across the gap before the decking is laid.

Both single- and double-storey bridges are launched with the aid of a central launching nose—a light alloy beam which is long enough to touch down on the far bank before the centre of gravity of the whole bridge assembly passes beyond the launching rollers. When the end of the launching nose reaches the far bank a roller is placed to receive it.

The following tables show the maximum permissible spans. As a rough guide, the Class number can be taken as an indication of the vehicle weight in short tons (1 short ton = 907kg).

Single-storey spans

Class 60	9·1 metres (30ft)
Class 30	14·6 metres (48ft)
Class 16	21·9 metres (72ft)

Double-storey spans

Class 60	30·5 metres (100ft)
Class 30	41·4 metres (136ft)
Class 16	48·7 metres (160ft)

MINISTRY OF DEFENCE
Director of Sales (Army)
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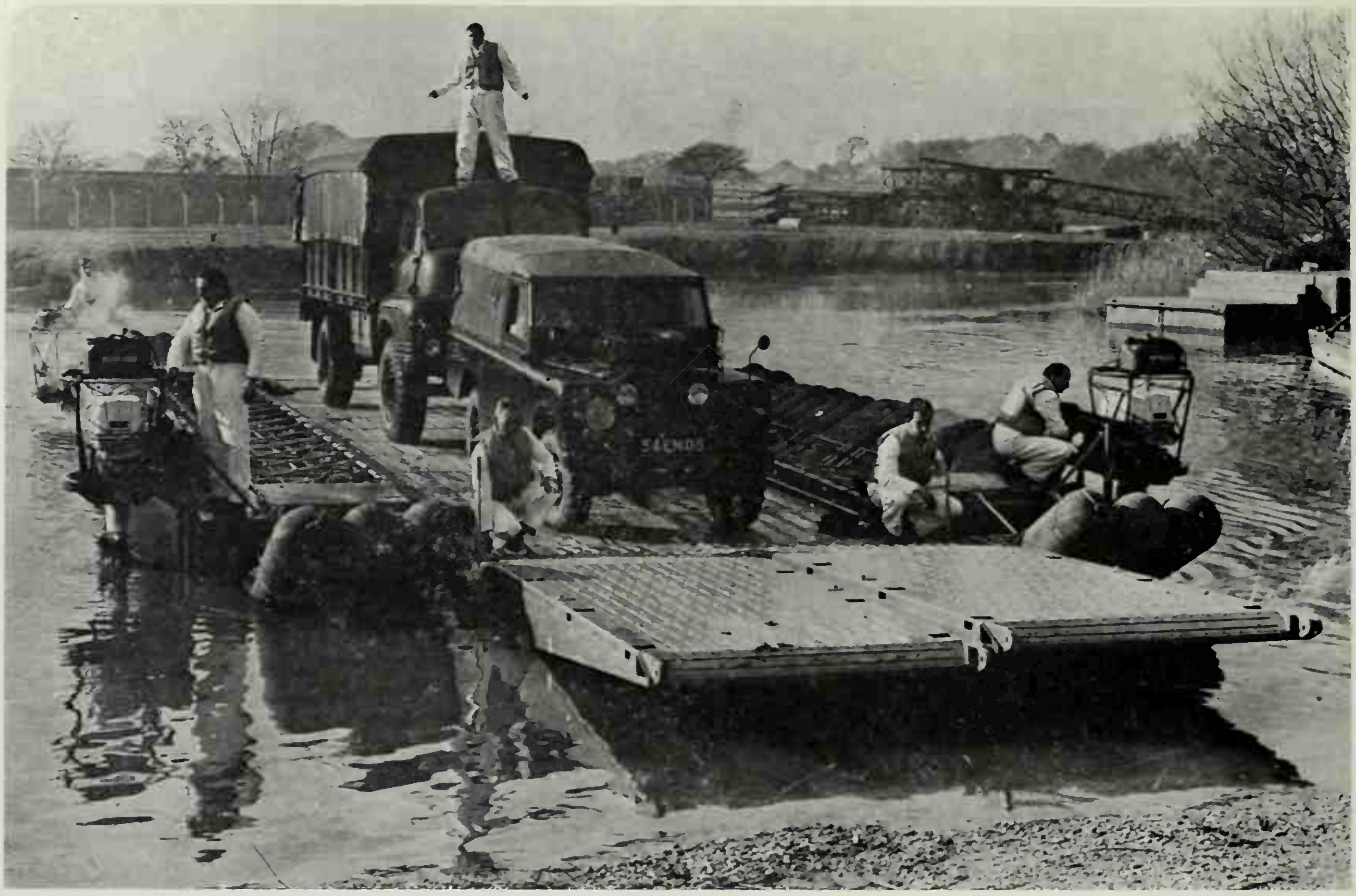
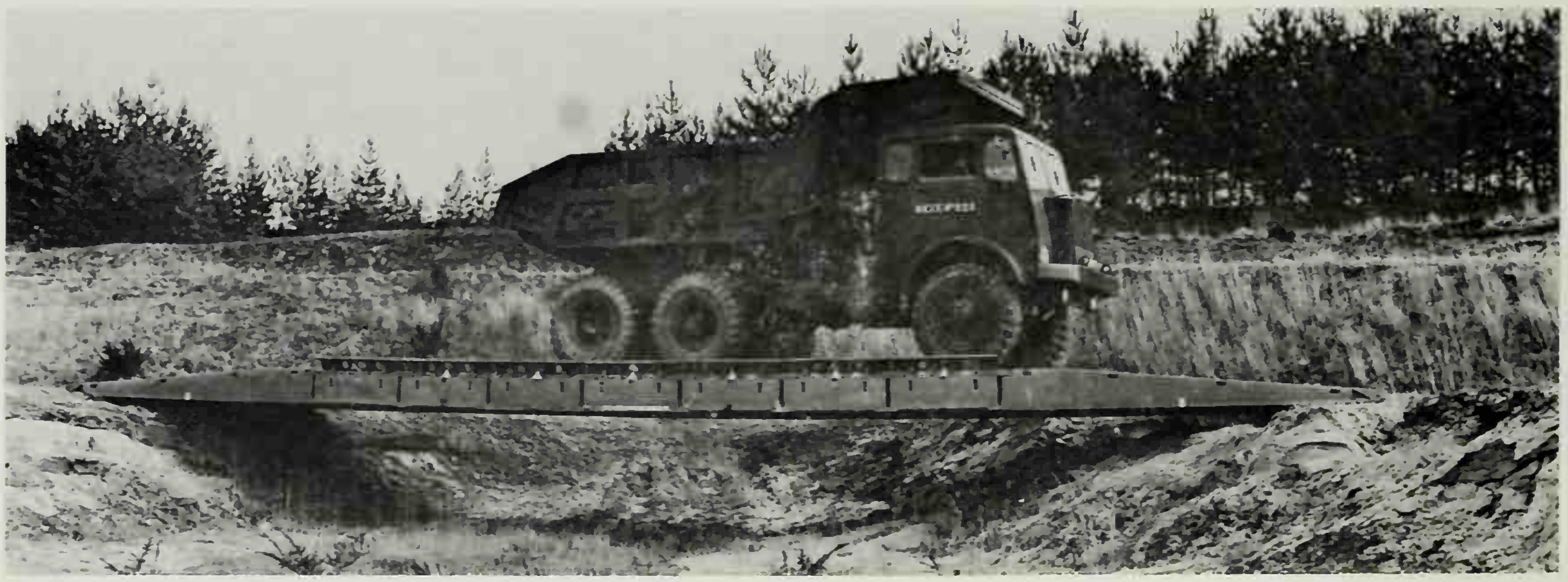
Telephone: 01-928 7999



Components assembled in powered raft form moving in to a landing point



The Class 16 bridge in clearspan form with seven deck boxes

Using special carrying bars, a squad of eight men can easily carry a deck box between transport trailer and assembly area over any reasonable distance

Trailer with four deck boxes. Articulator boxes, ramps and sponsons are similarly carried. Floats (deflated) are normally carried in the towing truck

Portable bridges

for clearspan, floating and raft applications

The Class 16 bridge is lightweight hand-erected equipment capable of being assembled as a clearspan bridge, a floating bridge or as a powered raft. Made of high-strength aluminium-zinc-magnesium alloy, it is designed for ease of transport and handling. Its basic components can be quickly assembled and placed into use. Each component has integral interlocking fittings and, when assembled, the equipment provides a clear non-skid roadway 3·3 m (11 ft) wide.

General description

The basic components of the Class 16 bridge are deck boxes, ramps, articulator boxes, floats and sponsons.

The deck box combines the functions of bridge girders and cross girders and contributes buoyancy in floating applications. The top of the box forms the deck of the bridge.

Tapered ramps are fitted to each end of the bridge to provide an easily negotiable access.

Hydraulically operated articulator boxes are fixed between the deck boxes and the ramps to allow adjustment for varying bank heights with floating bridge and raft applications.

For floating bridges and rafts, pneumatic floats are fitted to the deck boxes to give additional buoyancy and stability.

Sponsons with integral turntable brackets for 40 hp Johnson outboard motors are fitted at each corner of a floating raft for powered raft operations.

Clearspan bridge

A 15·2 m (50 ft) clearspan bridge is assembled from seven deck boxes and two pairs of ramps. The bridge can be constructed and positioned by 16 men in approximately 20 minutes using a special launching nose and rollers.

Floating bridge

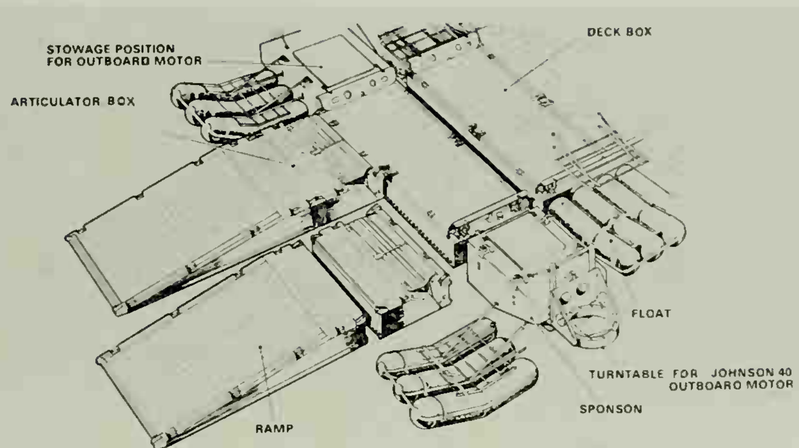
A floating bridge 58 m (192 ft) long can be assembled from 40 deck boxes, two pairs of articulator boxes, two pairs of ramps and floats using a standard bridge set, but there is no limit to the length of floating bridge that can be built.

Powered raft

The standard raft has a 12·2 m (40 ft) level deck and is 22 m (72 ft) overall. It is assembled from 10 deck boxes, two pairs of articulator boxes, two pairs of ramps, floats and four sponsons with outboard motors. The building time is approximately 40 minutes with 24 men. Longer rafts may be built up to 28 m (92 ft) overall and operated for a total distributed load of 24 tons.

Transport

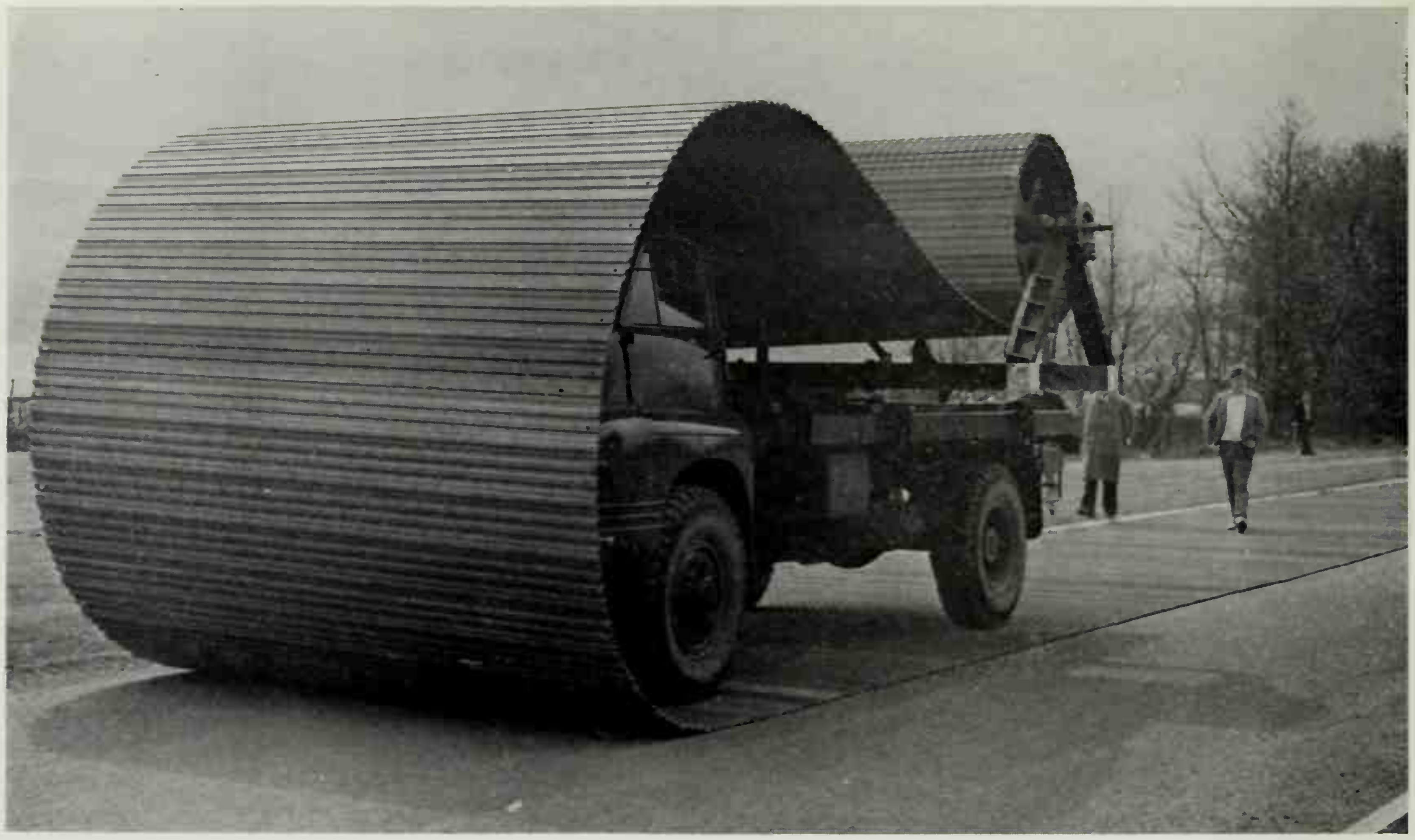
Component sizes and weights enable bridge and raft sets to be economically and easily moved overland on special trailers towed by Land Rover or similar trucks. The equipment may also be carried in strategic transport aircraft or by helicopters.

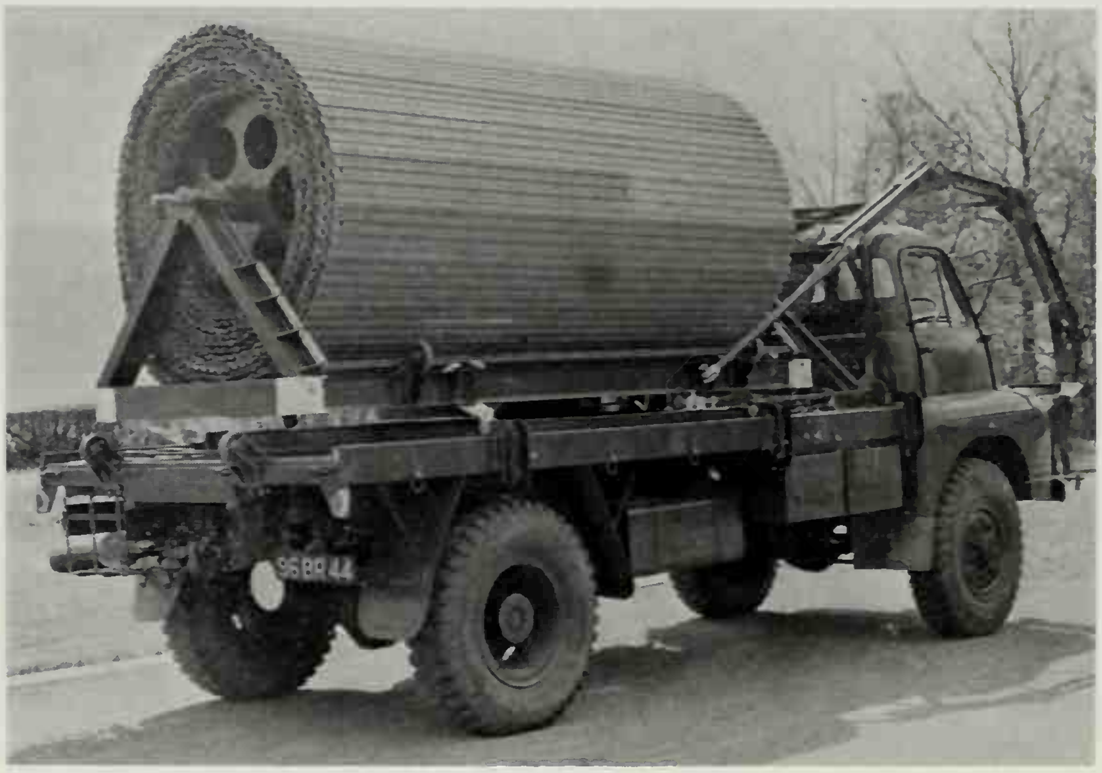

STOWAGE POSITION FOR OUTBOARD MOTOR
ARTICULATOR BOX
DECK BOX
FLOAT
TURNTABLE FOR JOHNSON 40 OUTBOARD MOTOR
SPONSON
RAMP

Dimensions and weights

Component	Length		Width		Depth		Weight	
	m	in	m	in	m	in	kg	lb
Deck box	3·6	144	1·2	48	0·38	15	273	600
Ramp	3·6	144	1·8	72	0·38	15	304	670
Articulator box	1·8	72	1·2	48	0·38	15	251	550
Float and support frame	2·0	78	1·2	48	0·75	30	23	50
Sponson (with motor fuel tank and anchor)	2·0	78	1·2	48	0·75	30	329	724

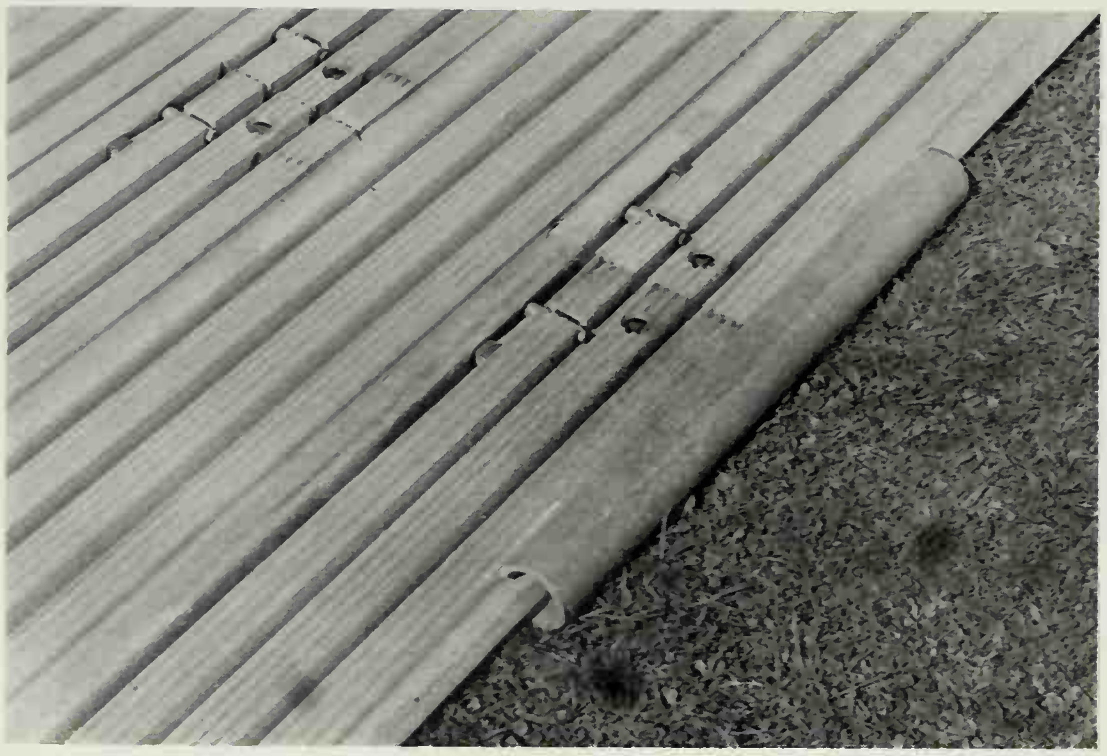
CAMMELL LAIRD (ANGLESEY) LIMITED
Beaumaris, Anglesey, North Wales
Telephone: Beaumaris 431 Cables: Searoads Beaumaris Telex: 61295





Speed of launching and recovery combined with low maintenance costs have resulted in Class 30 Trackway being specified as standard military equipment in many countries. Launching is normally carried out over the front of the vehicle and this can be completed in a few minutes by a team of three men

A roll of Class 30 Trackway may be transported on any suitable 5-ton flat platform truck. The roll is mounted on a spool and turntable which permits the trackway to be positioned within the length and width of the vehicle without overhang. When the operation is complete, the launching equipment can if necessary be quickly removed, so releasing the vehicle for other duties



The demand for a heavy-duty quickly assembled roadway capable of supporting both tracked and wheeled vehicles is met by the Class 60 Trackway. It is commonly used at the approach to and exit from temporary bridge and ferry sites and, in conjunction with Class 30 Trackway, is ideal for operations involving the combined use of tracked and wheeled vehicles

Portable roadways

truck-laid and heavy-duty types

Class 30 and Class 60 Trackway are portable non-skid surfacings designed for use on soft ground where conditions would become increasingly difficult with continual traffic and eventually result in total immobilisation of vehicles and mobile equipment.

Both classes of Trackway are engineered for easy transportation and rapid handling so that they can be placed quickly and effectively by the minimum number of men.

Trackway can be easily taken up after use, transported elsewhere and re-laid. Simplicity of construction and the use of aluminium alloy planks result in a very low maintenance and replacement factor.

Cammell Laird (Anglesey) Limited manufactures and supplies all components for these portable roadway systems.

Class 30 Trackway

Application

Class 30 Trackway is designed for wheeled vehicles and for tracked vehicles with rubber pads. Heavier vehicles can use the Trackway when ground conditions are favourable and tanks up to Class 50 may cross at an angle provided they do not slew while on the track.

Class 30 Trackway is a simple, quick and highly efficient means of maintaining vehicle movement over soft ground, particularly in conjunction with amphibious or other temporary bridges where its application extends the choice of crossing point.

One of the main features of Class 30 Trackway is that it can be launched and recovered by the transport vehicle and can therefore be put into use without delay.

Assembly

Class 30 Trackway is assembled from a number of extruded aluminium alloy planks with interlocking captive tongue-and-groove joints, forming a continuous non-skid surface 3·35 m (11 ft) wide and normally 49·95 m (150 ft 9 in) long. This standard Trackway length is reeled on to a carriage assembly transported by normal platform trucks. Class 30 Trackway is launched from the truck and later recovered on to the truck.

The spool carrying the length of track is mounted on a frame and turntable assembly which clamps to the truck platform. This arrangement permits the equipment to be stowed within the vehicle dimensions or swung to the launching and recovery positions.

Launching

Class 30 Trackway is launched forward over the truck cab, using a quickly fitted removable roller frame launching assembly. The track may also be launched over the rear of the truck. The preparation and launching operation can be completed in about ten minutes by a three-man team.

Recovery

Class 30 Trackway is recovered over the rear of the vehicle, being rewound on to the spool by ratchet levers. Roller supports clamped to the rear of the truck platform support the track clear of the truck. The recovery operation can normally be completed in 10 to 15 minutes by a four-man team.

Dimensions and weights

Standard Class 30 Trackway
Length: 45·95 m (150 ft 9 in)
Width: 3·35 m (11 ft)
No of planks: 201
Weight per m(ft) run: 62 kg (45 lb) approx
Individual plank: 3·35 × 0·23 m (11 ft × 9 in) 14·9 kg (33 lb)
Carriage assembly: 760 kg (1672 lb) approx
Launching assembly: 340 kg (750 lb) approx
Recovery equipment: 41 kg (92 lb) approx
Total weight trackway and components: 4218 kg (9298 lb) approx

Class 60 Trackway

Application

The Class 60 heavy-duty Trackway is designed for both tracked and wheeled vehicles. In general it is used to support tanks over very soft ground and in areas of large vehicle concentrations such as may occur at bridge and ferry approaches, at the entry and exit to marshalling areas and other areas subject to heavy traffic.

Class 60 Trackway is also used to protect Class 30 Trackway at tank crossing points.

Class 60 Trackway is quickly and easily assembled and the components can be transported in quantity by standard trucks.

Assembly

The heavy-duty Trackway is assembled from interlocking extruded aluminium alloy planks made in two sizes: 4·57 × 0·23 m (15 ft × 9 in) and 2·28 × 0·23 m (7 ft 6 in × 9 in). These dimensions enable a continuous load-carrying mat to be assembled quickly over areas of soft ground. The method of assembly is by sliding individual planks together successively and engaging a simple locking device. An access mat area 18·3 × 11·6 m (60 × 38 ft) can be assembled in four hours by ten men. A pre-assembled length of Class 60 Trackway 7·6 × 4·6 m (25 × 15 ft) secured in a roll is easily laid and recovered by ten men. Tanks are driven on to the mat over the longitudinal lay of the planks. Slewing can take place once the tracks are fully on the mat.

Transport

Class 60 Trackway component dimensions permit transport in quantity by standard trucks and easy handling at both loading and application points.

Two 3-ton trucks can transport components for assembly of a trackway area measuring 18·3 × 11·6 m (60 × 38 ft). Components for assembling a roadway 15·3 m (50 ft) in length and 4·6 m (15 ft) wide can be loaded on one 3-ton truck as loose planks or as a single pre-assembled roll or as two pre-assembled rolls each 7·65 m (25 ft) long.

Dimensions and weights

Typical Class 60 Mat
Length: 18·3 m (60 ft)
Width: 11·6 m (38 ft)
Area: 212 m^2 (2280 ft^2)
Weight per m^2 (ft^2): 34 kg (7 lb)
Total weight: 7182 kg (15 960 lb)

Typical Class 60 Track
Length: 15·3 m (50 ft)
Width: 4·6 m (15 ft)
Weight per metre (ft) run: 144 kg (105 lb)
Total weight: 2385 kg (5300 lb)

Individual planks
Long plank—Length: 4·57 m (15 ft)
Width: 0·23 m (9 in)
Weight: 33·07 kg (73 lb)
Short plank—Length: 2·28 m (7 ft 6 in)
Width: 0·23 m (9 in)
Weight: 16·76 kg (37 lb)

CAMMELL LAIRD (ANGLESEY) LIMITED
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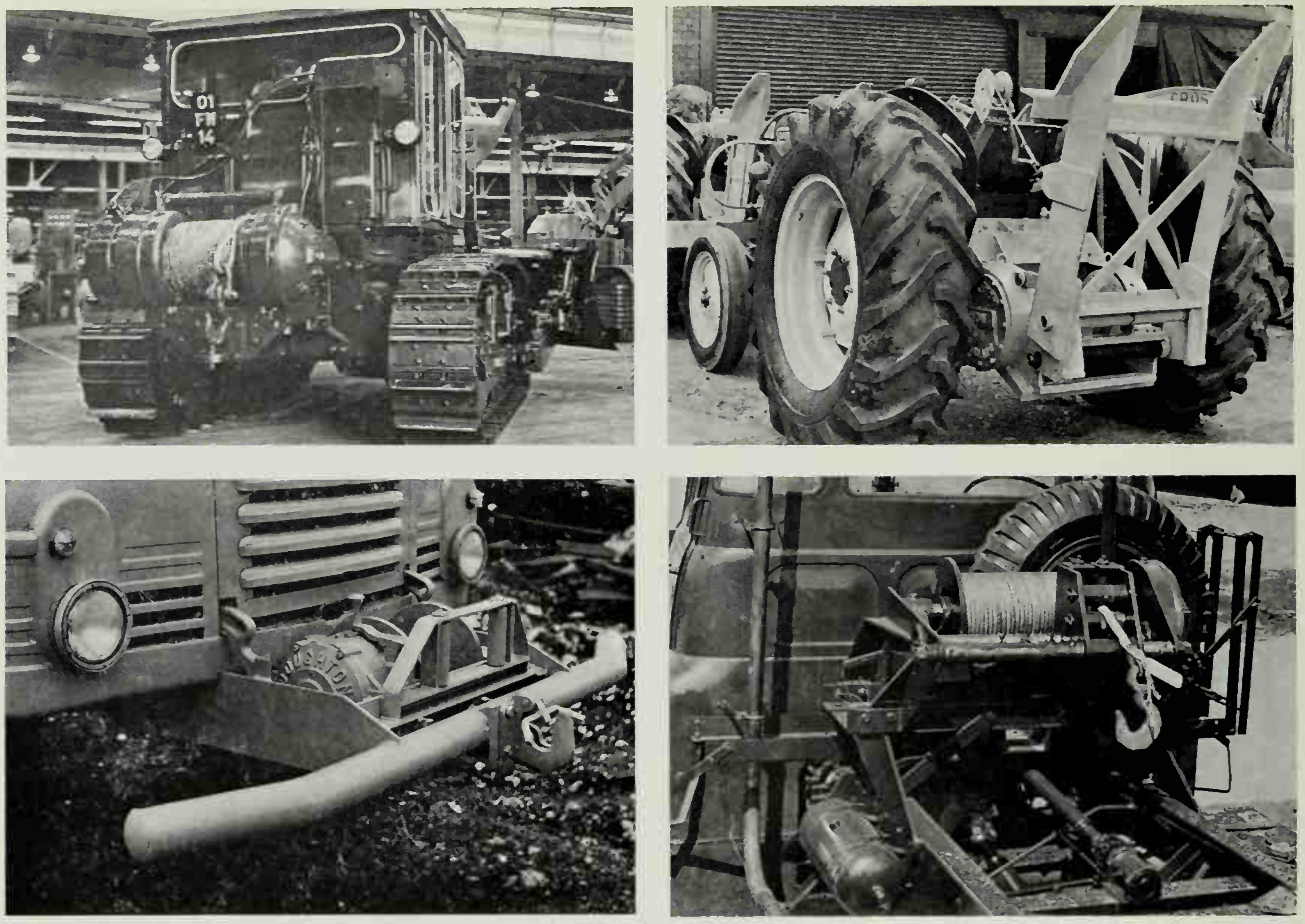
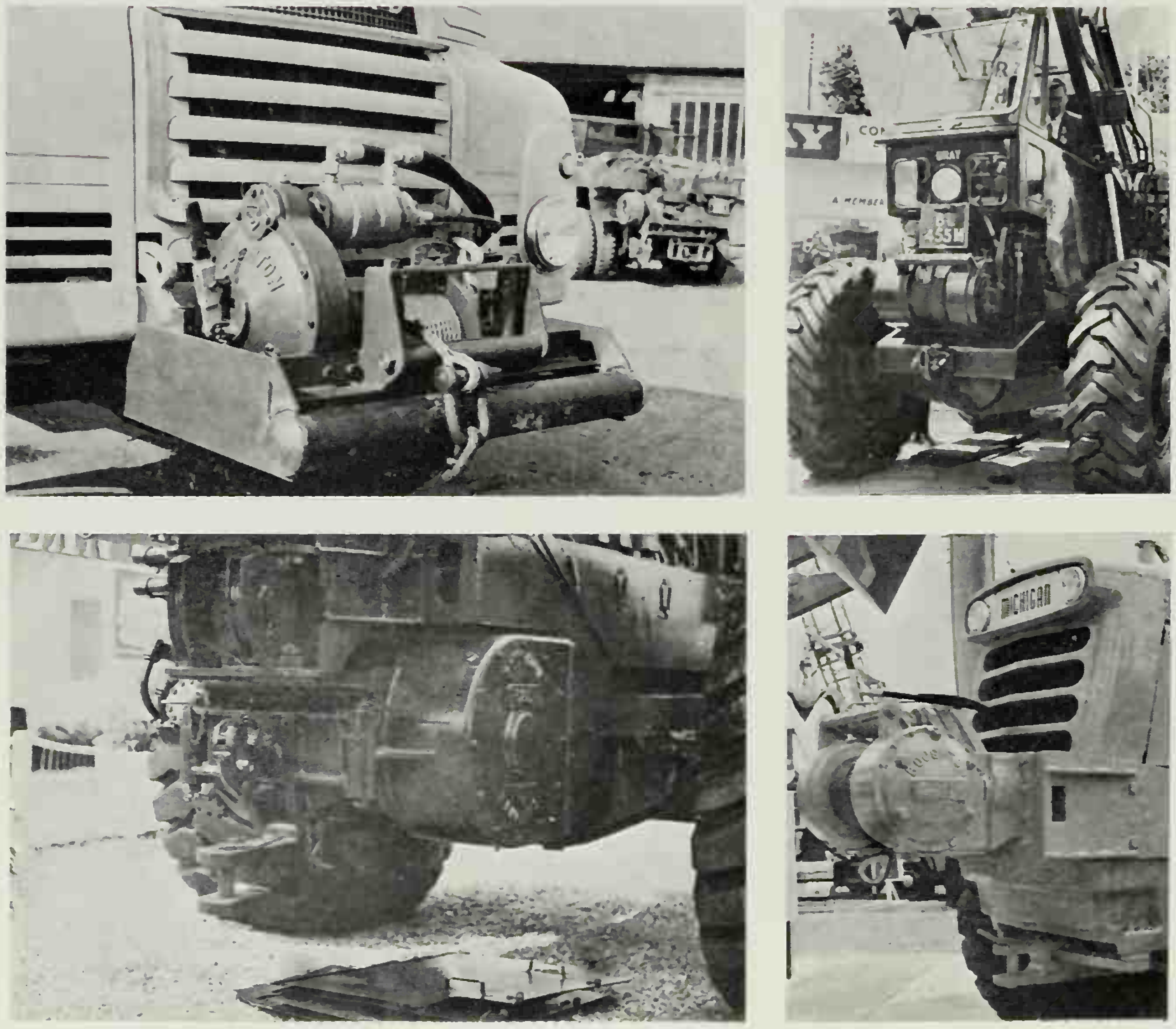


Examples of mechanical winches

Examples of hydraulic winches



Winches

for mounting on wheeled and tracked vehicles

As one of the oldest established manufacturers of winches, T T Boughton offers a comprehensive range of units suitable for use on vehicles, wheeled or crawler tractors, or for special applications.

Mechanically driven from the power-takeoff shaft, the small end of the range is suited to vehicles or lightweight tractors; it starts at 2720kg (6000lb) line pull and increases through subsequent models to 22 680kg (50 000lb) line pull.

A variety of optional equipment is readily available, such as alternative gear ratios, two-speed gearboxes, freespool and automatic brake, four-roller fairleads, choice of underwind or overwind in most models and drums of varying width.

For heavier wheeled tractors and for the bigger crawler types, winches with line pulls of up to 31 750kg (70 000lb) are in regular production with the optional equipment as mentioned above.

Partial or complete waterproofing is available on some models for beach landing craft and similar applications. (Regarding special applications, a unit providing 200 tons line pull went into service this year.)

In addition to their mechanically driven units, T T Boughton has pioneered and developed a range of hydrostatic winches, actuated by hydraulic motors. This group of seven models is also suited to vehicles, wheeled and crawler tractors or to special applications. Capacities range from 2720kg (6000lb) to 27 210kg (60 000lb) line pull and varying line speeds.

Apart from the smooth shockless functioning so characteristic of hydraulic power, hydrostatic winches permit many more permutations and combinations than the mechanical types. Not only can a range of optional gear ratios be used between the motor and the winch drum, but pumps providing different flow rates may influence line speed, while variations in hydraulic pressure can increase or diminish line pull.

Optional equipment such as automatic brakes, fairleads, etc, are available.

Mechanical specification

As a typical specification the characteristics of the Model V 19 mechanical winch are as follows:

Drum dimensions
Barrel diameter: 165mm (6½in)
Flange diameter: 355mm (14in)
Between flanges: 398mm (15⅝in)

Rope capacities
91m (100yd): 15·8mm (⅝in) dia
100m (110yd): 14·2mm (9/16in) dia
118m (130yd): 12·7mm (½in) dia

Maximum line pull 11 340kg (15 000lb) on bare drum

Gearing Worm: final drive providing 30:1 ratio. Worms are nickel-chrome steel. Worm gears are cast in high-grade bronze and teeth accurately generated by hobbing. Housing in-line bored

Main shaft 1½% nickel-chrome-molybdenum steel heat-treated and ground. Mounted in generous bronze bushings

Housing Steel casing to BS 592 Grade B

Automatic brake Totally enclosed in housing on worm shaft. Absolute safety against runback assured. No rearrangement of parts is required when changing from overwind to underwind or vice versa

Clutch Direct on drums. Sliding member of heat-treated alloy steel. Clutch and pad brake actuated by single lever

Catsheads Standard equipment

Cab controls All winches designed with longitudinal control rods and down-hanging levers when linkage is taken to control levers inside cab. Push-pull flexible cables simplify difficult installations

Basic weight 276kg (610lb)

Hydraulic specification

A typical specification of an hydraulic winch is that of the Model 2H:

Drum dimensions
Barrel diameter: 152mm (6in)
Flange diameter: 406mm (16in)
Between flanges: 304mm (12in)

Rope capacities with 304mm (12in) drum (standard)
12·7mm × 137m max (½in × 150yd). Recommended length 110m (120yd)
15·8mm × 91m max (⅝in × 100yd). Recommended length 91m (100yd)
19·0mm × 69m max (¾in × 75yd). Recommended length 46m (50yd)

Line pulls
11 340kg (25 000lb) at 12·2m/min (40ft/min) on bare drum
5670kg (12 500lb) at 24·4m/min (80ft/min) on full drum
assuming a pressure of 105kg/cm^2 (1500lb/in^2) and delivery of 145 litres/min (32gal/min) from the pump
Rope attachment to drum is by simple ferrule let into recess in side of drum flange; allows rapid changing of ropes and recoiling
Free drum is incorporated and allows easy pay-out of rope by hand when required. Free drum clutch is of the internal and external toothed type, operated by lever. By applying the brake, this clutch can be disengaged easily even if the winch rope is under load

Brake 280mm (11in) dia, self-energising for over and underwind, and requires very little effort on hand lever to give a very powerful grip. External contracting band is operated by over-centre toggle mechanism. Brake drum and band are totally enclosed ensuring freedom from dirt and moisture in the mechanism
Towing on the winch brake is ensured without slip on tractor up to 65hp tractors. Ratchet hand brake (standard)

Control levers Brake and free drum levers are grouped for ease of operation from seat or ground. Winch is operated by control valve with forward and reverse selection lever which automatically returns to neutral position when released, causing hydrostatic lock as safety precaution. Very fine inching control and cushioned pull is obtained on this winch

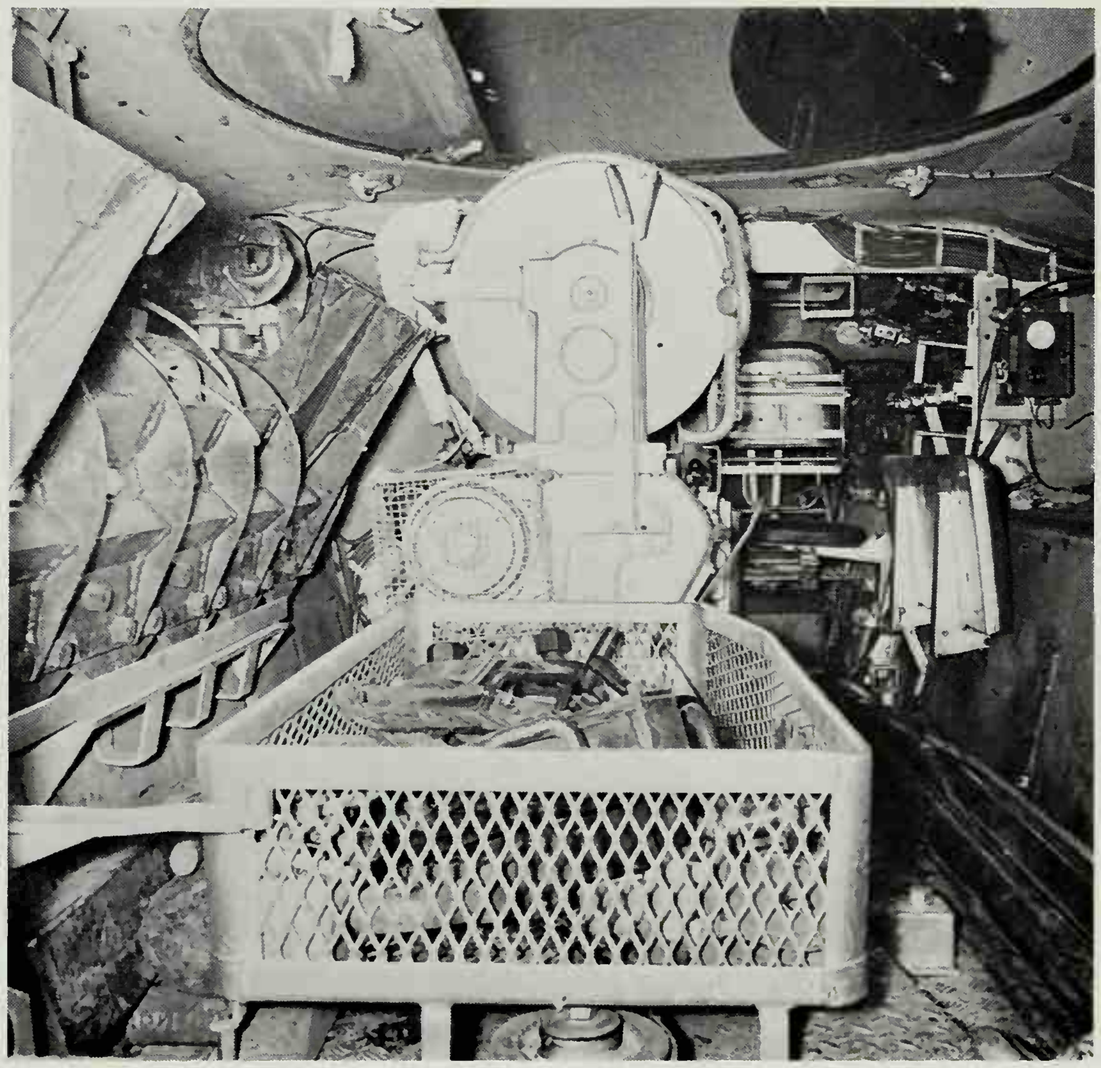
Transmission All gears, clutches, etc, are made of ample strength materials, heat-treated as required and run in totally enclosed oil baths. The winch is designed for continuous hard working with long life and freedom from failures and breakdowns. Taper rollers, ball and parallel roller bearings are fitted throughout, and are continually lubricated by winch transmission

Nett weight 304mm (12in) drum, main winch only 460–510kg (9–10cwt) approx without rope

T T BOUGHTON & SONS LIMITED
Engineering Division
Bell Lane, Amersham, Buckinghamshire, England
Telephone: Little Chalfont 2666 Cables: Boughtons Amersham Telex: 83132

Plumett auto-capstan winch Type CA-45

The Plumett auto-capstan winch and gearbox Type CA-45 is shown above fitted in a fighting vehicle Type FV432; a brief specification is given above. A similar model is available for mounting on the Bedford 4 × 4 army truck shown elsewhere in this Catalogue

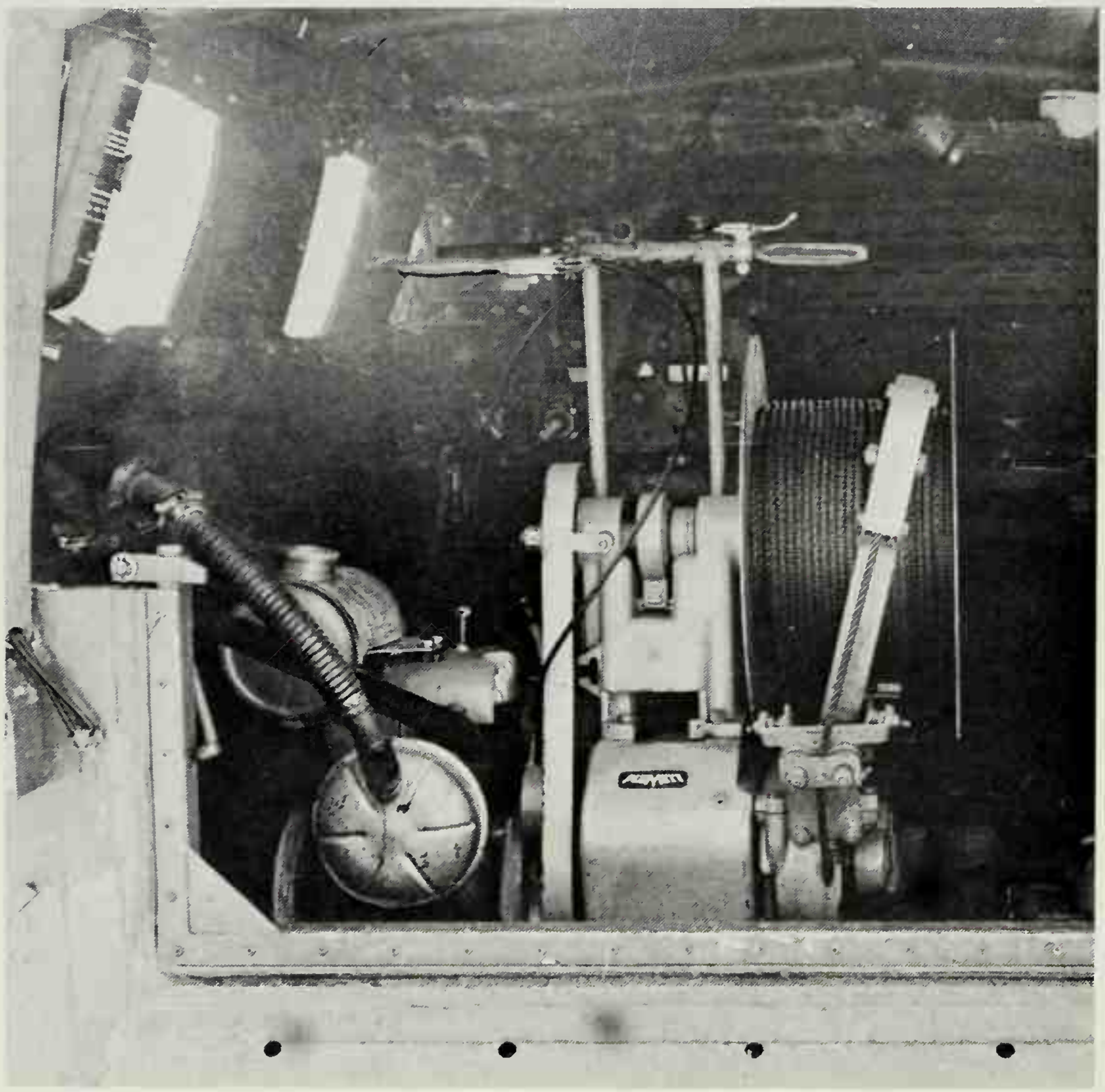


Specification

Power: through power-takeoff from fighting vehicle
Max rope pull at hook: low gear 6500 kg; high gear 3000 kg
Rope speeds: low gear 4·5–18 m/min; high gear 33–132 m/min
Diameter of rope: 14 mm
Max length of rope: 250 m
Breaking load of rope: 11 200 kg
Weight (excluding rope): 470 kg

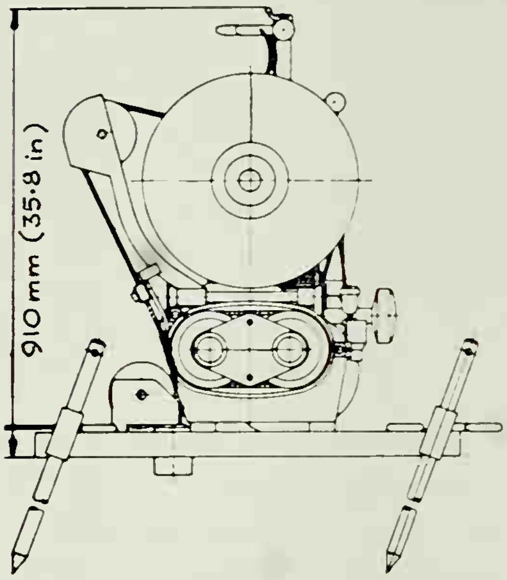
Plumett transportable motor winch

The illustration and diagram below show the Plumett portable motor winch Type TL-20; in the photograph it is shown carried on a BM Volvo Type BV 202 truck. Brief specifications of Type TL winches with integral 5, 9 and 15 hp drives are given in the specification below



Specification

Power: integral two-stroke engine (5, 9 or 15 hp) through centrifugal clutch
Max rope pull at hook: 2000 kg (5 and 9 hp); 2200 kg (15 hp)
Rope speeds: 0·07–0·28 m/sec (5 hp); 0·15–0·6 m/sec (9 hp); 0·2–0·8 m/sec (15 hp)
Dia of rope: 8 mm or 9 mm
Max length of rope: 300 m × 8 mm or 210 m × 9 mm
Breaking load of rope: 4000 kg (8 mm); 5150 kg (9 mm)
Weight (excluding rope): 140 kg



Capstan winches

vehicle-mounted or with own power unit

Plumett capstan winches are robust units suitable for a wide range of recovery, construction and similar work. Their essential feature is that the steel rope is winched by a multiple-groove twin pulley block, ensuring uniform speed at any point on the rope, while the rope itself is stored on a separate drum, as shown in the diagram below.

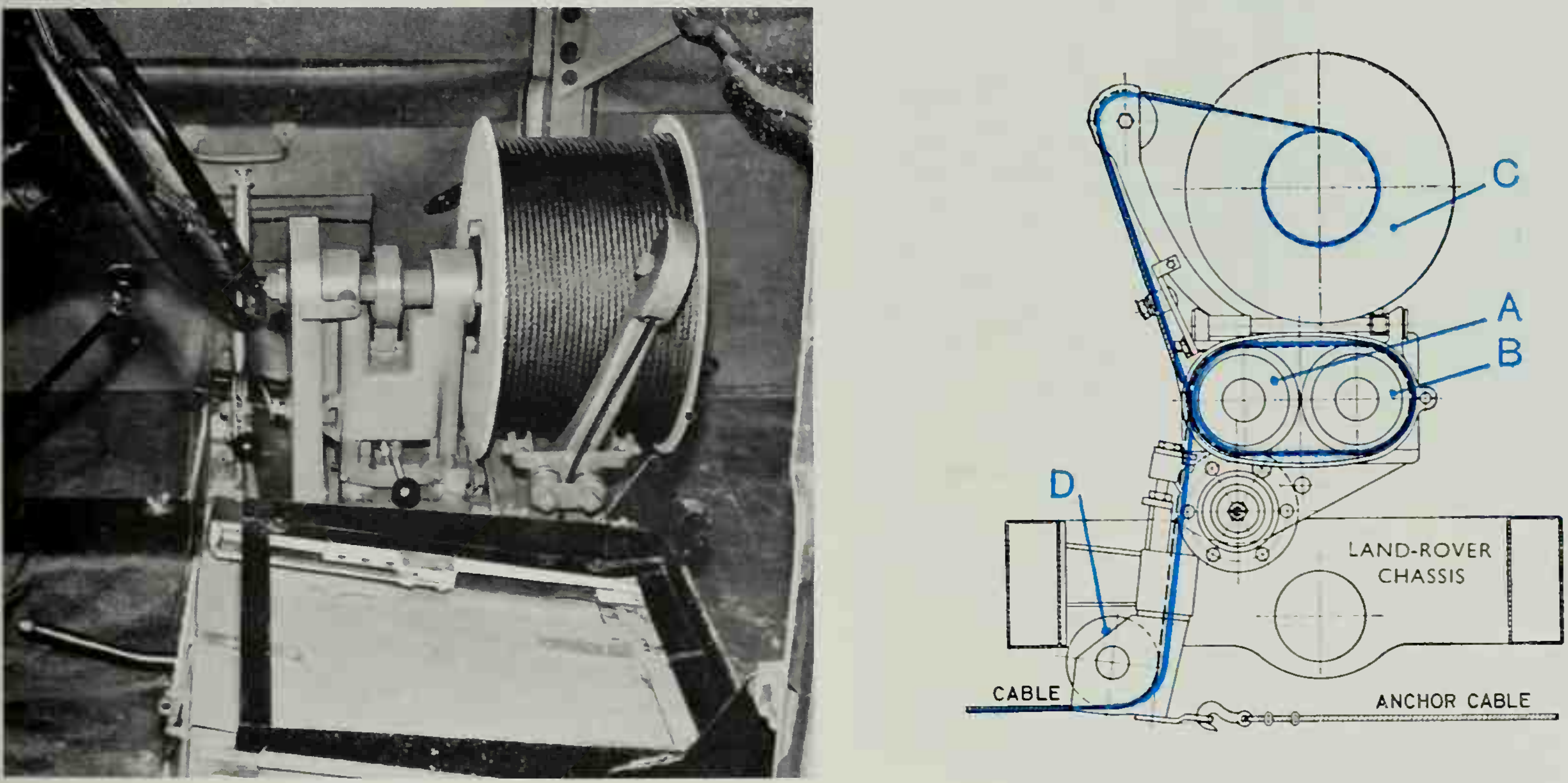
The advantages of this design are that a great length of steel rope can be carried, that speed can be controlled and maintained very accurately over a wide range, and that pay-out of the rope can be power-assisted. Further features of the design are automatic rope laying on the drum, a free-wheel brake to prevent run-back under load, and overload protection devices; an hydraulically operated braking system is available optionally.

Plumett winches are available in two ranges: the CA series, which is intended for vehicle-mounting and is driven through a power-take off from the vehicle power unit, and the TL, which is portable and completely self-contained, having its own power unit.

Plumett auto-capstan winch Type CA-15

This winch can be fitted to all models of Land Rover, a typical method of mounting being shown below. Apart from military purposes, this winch is being used by electricity companies for cable-stringing and laying, by fire-fighting and post office services, by civil engineers and many others.

A brief specification for the CA-15 winch is given below; the specification for the larger and more powerful CA-45 winch is on the opposite page.



Plumett CA-15 winch installed in a Land Rover (left) shown here with the driver's seat removed to give a better view. The principle of operation (right) is that the power of the motor is transmitted to the steel rope by the multiple-groove pulley block A and B. The drum C, driven by a friction clutch, ensures adhesion and stores the cable passed by the multiple-groove pulley block. The pulley D can turn through 360°, allowing traction in all directions.

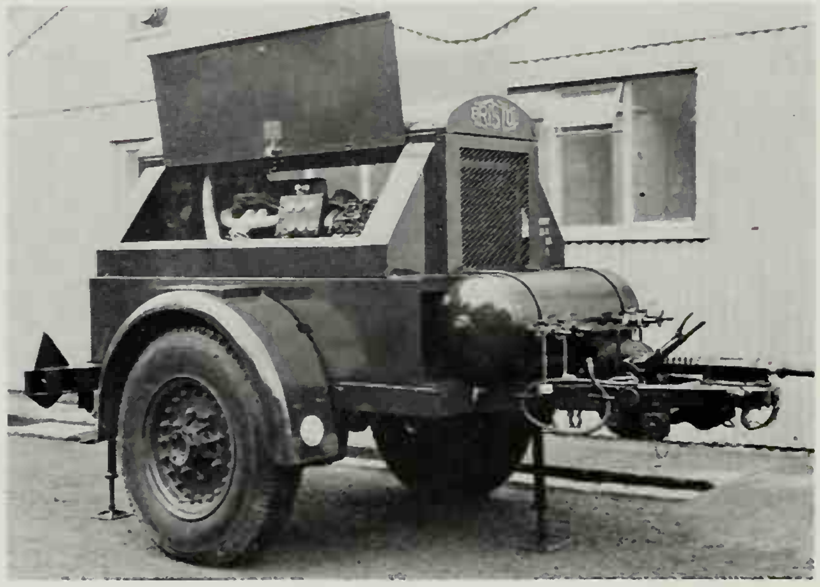
Specification

Power: through power-takeoff from vehicle
Max rope pull at hook: 1500 kg
Rope speeds: 0·3 to 4·0 m/sec
Diameter of rope: 8 mm or 9 mm
Max length of rope: 230 m × 8 mm dia or 170 m × 9 mm dia
Breaking load of rope: 4100 kg (8 mm dia); 5150 kg (9 mm dia)
Weight (excluding rope): 95 kg

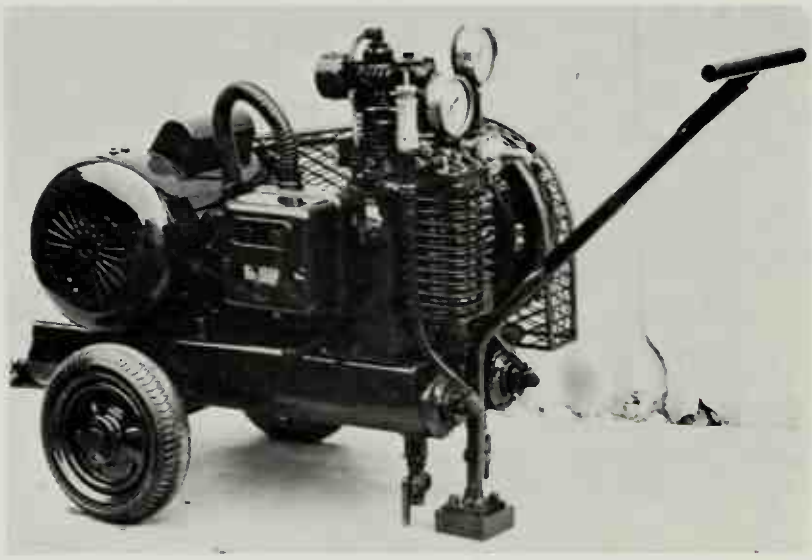
FULLER, LUCAS & COMPANY LIMITED
Crowborough Cross, Eridge Road, Crowborough, Sussex, England
Telephone: Crowborough 2000 Cables: Lucas Crowborough Telex: Lucas Crowborough/Chamcom London 261981

Air compressors

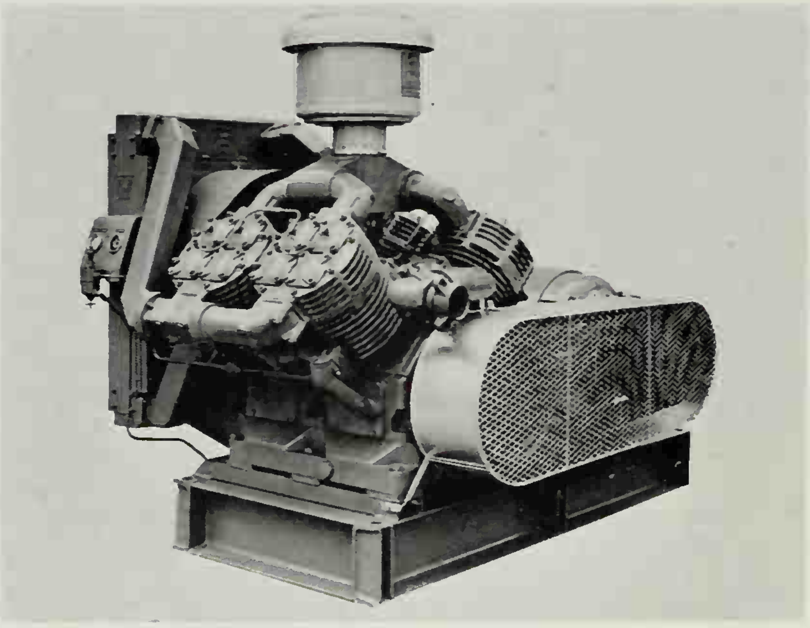
Portable and stationary models



Portable air compressor Model ATS/150/WD



Portable tyre inflator Model 306/JL.5



Heavy-duty stationary compressor Model 308/ATS/500

Bristol Duplex air compressors of all types are available for a wide range of applications. The current range includes diesel-driven portable plants for construction work, light industrial and heavy-duty units for workshop use, high-pressure models for laboratories and air-bottle charging, garage compressors, and tractor-mounted plants.

The patented Duplex airflow-cooled, two-stage design embodied in all Bristol air compressors enables the machines to deliver a greater volume of usable air for a given horse power. This design uses a stepped piston and cylinder to enable both stages of compression to be carried out in any one cylinder. Efficient airflow cooling of the high-pressure area of the cylinder, together with inter-cooling carried out between stages, results in very cool-running compressors with high volumetric efficiency.

In addition, the double-acting piston does an equal amount of work on each stroke and plants run relatively free from vibration while the short stroke inherent in this design gives low piston speeds with consequent reduction in wear.

Bristol Duplex air compressors, large numbers of which are serving with the armed forces of British and other NATO countries, have undergone the most stringent tests. These include subjecting the plants to ambient temperatures ranging from +52°C to –40°C with no detrimental effect to performance.

Free air delivery figures are quoted for every Bristol air compressor and are guaranteed to the relevant British Standard Specifications and all international equivalents.

Specification

Model ATS/150/WD
Two-wheeled trailer-type portable diesel-driven air compressor, air-cooled, two-stage. Free air delivery 3·68 m^3/min (130 ft^3/min). Working pressure 7·0 kgf/cm^2 (100 lbf/in^2)
Other sizes available from 1 m^3/min to 9 m^3/min (36–320 ft^3/min)

Model 306/JL.5
Compact tyre inflator air compressor, air-cooled, two-stage, easily transportable. Free air delivery 0·1 m^3/min (3·5 ft^3/min). Working pressure up to 10·5 kgf/cm^2 (150 lbf/in^2)

Model 308/ATS/500
Heavy-duty industrial-type compressor, air-cooled, two-stage. Free air delivery 11·3 m^3/min (400 ft^3/min). Working pressure 7·0 kgf/cm^2 (100 lbf/in^2)
Other sizes available from 0·1 m^3/min to 11·3 m^3/min (3·5–400 ft^3/min)

BRISTOL PNEUMATIC TOOLS LIMITED
Causeway Works, Fishponds, Bristol, BS16 3JS, England
Telephone: Bristol 657511 Cables: Percussion Bristol Telex: 44641

BPT
BRISTOL AIR

Portable electric tools

for field service from vehicle-mounted generator

The Consolidated Pneumatic Tool Company Limited, manufacturers of industrial high-frequency tools for over forty years, has produced in collaboration with the British Army authorities a range of specially adapted tools to meet most known requirements anywhere in the world under the severest conditions of climate and usage.

Known as the Hicycle range, these tools operate from the electric supply of 400 Hz, 200 V, adopted as standard for British Army service requirements.

For more comprehensive information, trade catalogues are available from the company or any of its branches and agents throughout the world.

Drills

The model No 157 MOD drilling machine has a capacity of 9·5 mm (⅜ in) for metal or wood drilling. Additional equipment available is a bench drill stand and 90° angle head.

The model No 40 H-MOD-490 is a 19 mm (¾-in) capacity drill for metal or wood drilling and earth boring to a depth of 1·2 m (47¼ in). Additional equipment includes a bench drill stand, wood bit chuck, earth boring chuck, rod and bit.

Grinders

The model No 511 G-MOD-5400 grinder is fitted with a 150 × 25 mm (6 × 1 in) wheel for general grinding. For sharpening tungsten carbide bits and tipped tools a 100 × 25 mm (4 × 1 in) wheel is fitted. A bench stand is available as additional equipment.

Wrenches

The model No 7250 MOD is a reversible impact wrench for tightening and removing nuts, driving metal screws up to 13 mm (½ in) diameter and wood screws up to No 14. Additional equipment includes a right-angle head, carrying case with set of sockets and screwdriver attachment.

Sanders

The model No 511 AS-MOD-5400 is fitted with a 230 mm (9 in) diameter abrasive disc for angle sanding. It can also be used for wire brushing with a 150 mm (6 in) diameter brush.

Shears

The model 200 MOD shearing machine cuts mild steel sheet up to 2 mm (14-gauge) thickness.

Saws

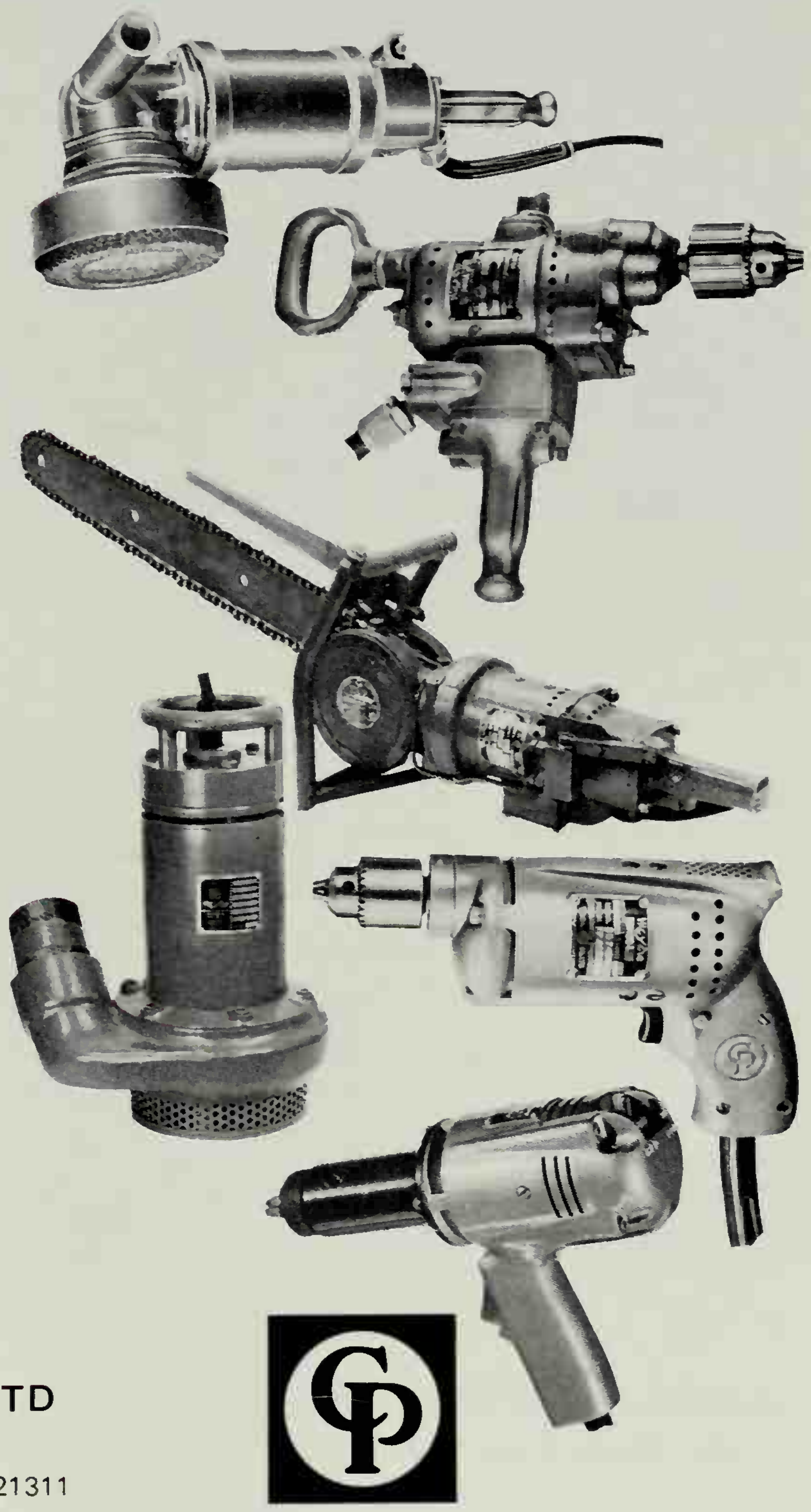
The model No 575 MOD chain saw is ideal for cutting timber and felling trees. Its overall length is only 1·19 m (46¾ in) including 584 mm (23 in) cutter bar. Its height is 280 mm (11 in) and the width is 240 mm (9½ in).

Screwdrivers

The model No 157 SC-750 screwdriver for driving metal or wood screws, with a capacity up to 6 mm (¼ in).

Pumps

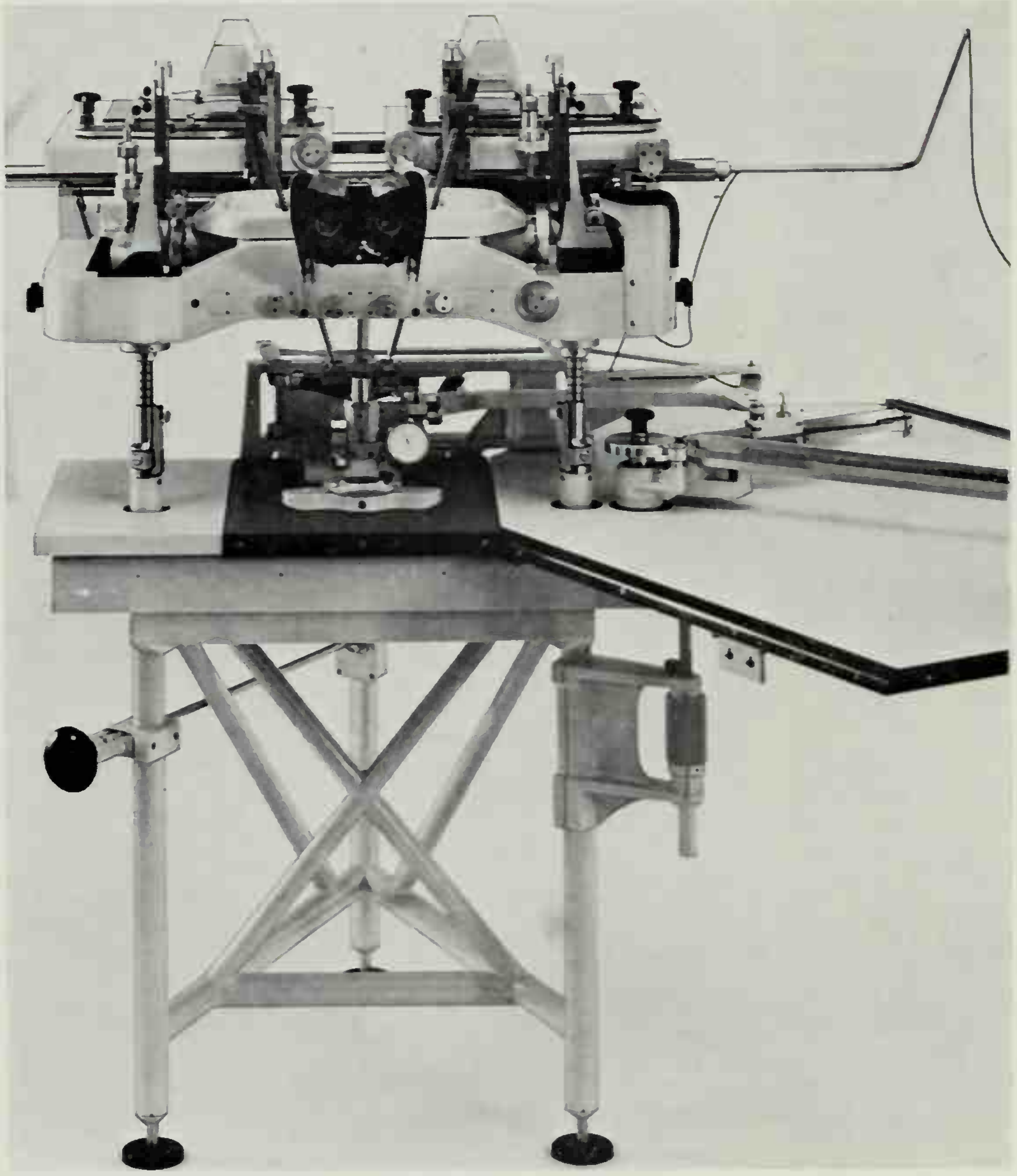
The new Hicycle sump pump has a capacity ranging from 545 litres/min (120 gal/min) at 6 m (20 ft) head ranging to 109 litres/min (24 gal/min) at 36 m (120 ft) head.



CONSOLIDATED PNEUMATIC TOOL CO LTD
97–107 Uxbridge Road, London W5, England
Telephone: 01-567 3411 Cables: Caulking London W5 Telex: 21311

Optical systems

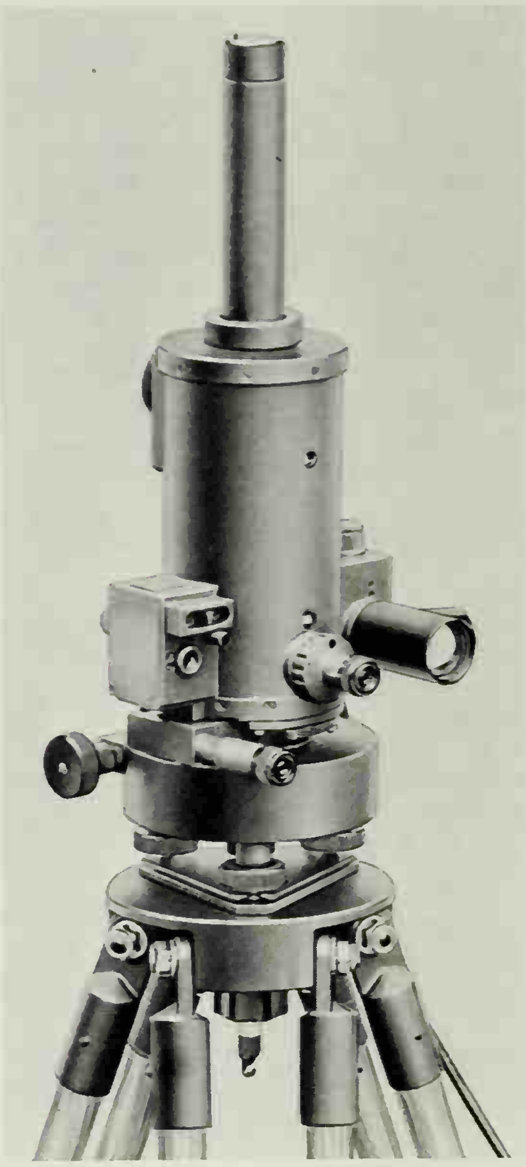
for photogrammetry and surveying



Defence Instruments (Optical) Ltd can supply a wide range of technical instruments for defence purposes, some of which are shown on this page. Periscopes, telescopes and other optical equipment for fighting vehicles are shown elsewhere in this Catalogue.

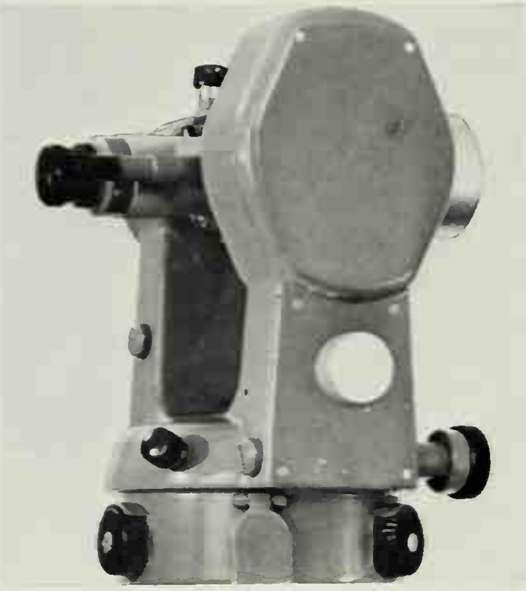
Photogrammetric equipment
Our range includes large-scale and small-scale plotters, mono and stereo comparators of 230 × 230 mm (9 × 9 in) and 460 × 230 mm (18 × 9 in) size, stereo scopes of 70 × 70 mm (2¾ × 2¾ in) and 230 × 230 mm (9 × 9 in) size, co-ordinatographs, photo-interpretation equipment, area-measuring instruments, scribing tools and digitising systems.

Surveying equipment
The range covers theodolites and levelling instruments, gyro-theodolites, electronic distance-measuring equipment, co-ordinate plotters, survey clinometers, magnetic compasses, plane table equipment, measuring tapes and bands, ranging poles and staves.



Full details of the equipment shown and listed here are available on request.

Defence Instruments (Optical) Ltd has a staff of specialists qualified to interpret technical requirements, to offer advice and to make recommendations on the choice of suitable equipment for the widest range of purposes.



DEFENCE INSTRUMENTS (OPTICAL) LTD
Sudbury House, Tylney Road, Bromley, Kent, England
Telephone: 01-460 4665 Cables: Optic Sales Edenbridge

Gas welding, cutting, brazing and soldering equipment

C S Milne & Co Ltd
Harley Works, Deptford, London SE8, England

Milne products, as supplied to the British Ministry of Defence, are available either separately or in working packs: a cutter and/or welding blowpipe, with gas regulators, hose projectors, hose and connectors.

The blowpipe range includes: 'Firecrest' weighing 100 g (3½ oz) for micro-welding and brazing foil and electronic circuit connections up to 1·6 mm (16-gauge) plate, 'Baby' and 'General' for welding 10–32 mm (0 gauge–1¼ in) mild steel plate and for cutting 0·5–76 mm (26 gauge–3 in) plate, 'Spitfire' for cutting up to 300 (12 in) plate and 'Seafire' for underwater cutting up to 230 mm (9 in) plate all with nozzles for most oxy/gas and air/gas fuel systems.

We also make acetylene generators.

Telephone: 01-237 9841 Cables: Acetyweldo London SE8

Section 12

Earthmoving equipment

The high driving seat on the Allis-Chalmers 645 ensures good all-round visibility. Its SAE rated operating capacity is 4082kg (9000lb)

Allis-Chalmers 645 Articulated Wheel Loader combines dependable power with excellent stability, speed and operating ease for high productivity

With its ability to swing through a full 90 degrees arc (45 degrees each way), the 645 can head into the pile or swing toward the truck with only a minimum of time-wasting linear travel

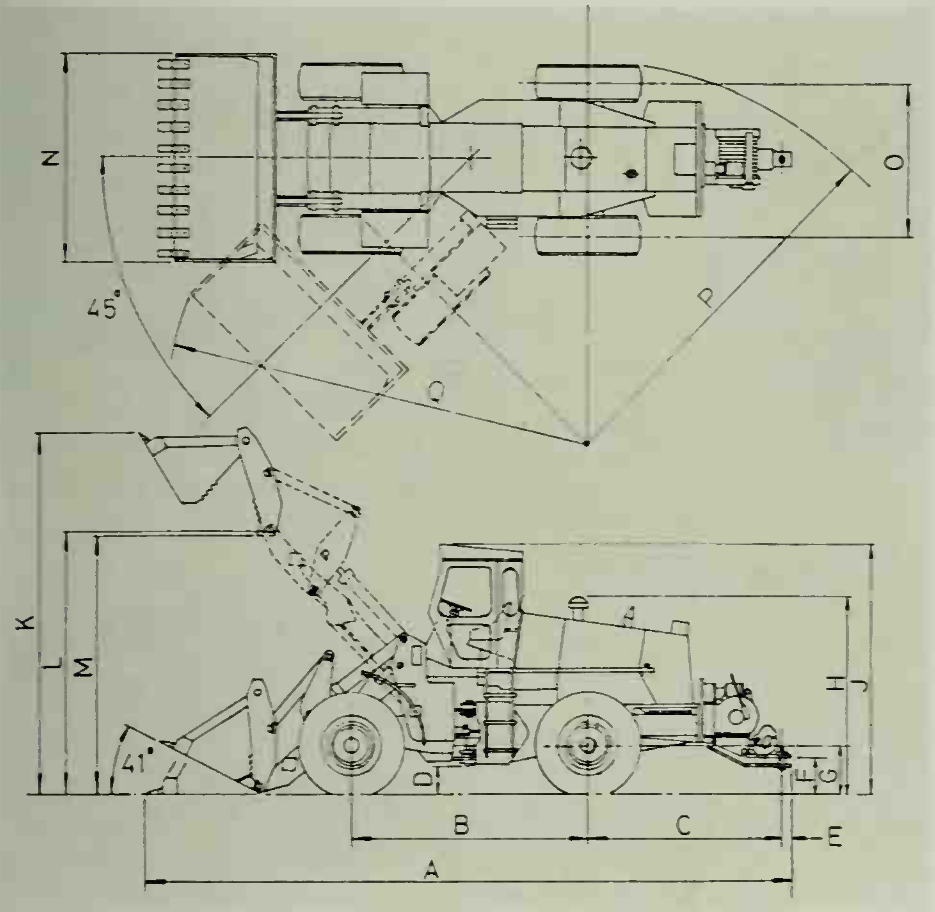
Earthmoving equipment

Articulated wheel loader

The Allis-Chalmers 645 is a rugged 2m³ (2½yd³) machine with an SAE rated carrying capacity of 4082kg (9000lb). The six-cylinder 142hp diesel provides a high horsepower-to-weight ratio.

Good weight distribution and long wheelbase combine to provide exceptional balance and stability. The 90 degree swing and axle placement equidistant from the joint centre line allows the loader to turn in a radius of only 5·4m (17ft 8½in).

The operator sits on a fully adjustable bucket seat Visibility to the bucket and the rear of the machine is excellent. Single-lever power—shift for on-the-move gear changing, both forward and in reverse (no stopping or foot clutching); power steering; air over hydraulic dual system brakes; push-button electric starting; easy-to-read gauges—all combine to make operation easy.



DIMENSIONS

A	Overall length (bucket on ground) 7·415m (24ft 4in)
B	Axle centres 2·945m (9ft 8in)
C	Centre rear axle to drawbar pin 2·006m (6ft 7in)
D	Ground clearance 457mm (1ft 6in)
E	Centre drawbar pin to rear of drawbar 50mm (2in)
F	Height to underside of drawbar top 482mm (1ft 7in)
G	Height to centre line of axles 711mm (2ft 4in)
H	Height to top of air cleaner stack cap 2·654m (8ft 8½in)
J	Overall height to top of cab 3·302m (10ft 10in)
K	Maximum height at full raise with clam fully open 5·721m (18ft 9¼in)
L	Height to hinge pin, fully raised 3·581m (11ft 9in)
M	Clearance when bottom dumped 3·473m (11ft 4¾in)
N	Maximum width, across bucket 2·692m (8ft 10in)
O	Track width 1·993m (6ft 6½in)
P	Outer turning circle (tyres) 4·813m (15ft 9½in) radius
Q	Outer turning circle (bucket) 5·397m (17ft 8½in) radius

Overall length less bucket and winch 5·486m (18ft 0in)

Overall length (bucket on ground) with scraper towbar stowed 7·264m (23ft 10in)

SPECIFICATION

Engine

AEC AV505 six-cylinder diesel
Maximum horsepower 142bhp at 2200rev/min
Service rating 89·6bhp at 1800rev/min
Maximum torque 52·2kg m (378ft-lb) at 1200–1400rev/min
Bore and stroke 116mm (4·56in) by 130mm (5·12in)
Displacement 8226cm³ (502in³)
Air cleaner dry, Donaclone 254mm (10in)
Fuel tank capacity 197 litres (43·5gal)

Power train

Transmission: Allison TT2420–1 with power shift. Changes from 1st to 2nd and 3rd to 4th are automatic
Converter: Allison twin turbine TT425, with stall ratio of 5·18:1
Forward speeds: 1st 4·8km/h (3·0mph); 2nd 10·6km/h (6·6mph); 3rd 18·8km/h (11·6mph); 4th 40·0km/h (24·8mph)
Reverse speeds: 1st 4·7km/h (2·9mph); 2nd 14·0km/h (8·7mph)

Axles

Planetary type, floating shafts, torque-proportioning hypoid gear differential, pin-connected to frame
Front: Rockwell/Centrax Model PR209, rigidly mounted to frame
Rear: Rockwell/Centrax Model PR111, pivot-mounted to frame

Tyres

Tubeless, 20·5 × 25, 20 ply

Brakes

Dual system, air over hydraulic with service line couplings for trailer braking
Service: double anchor pin, single cylinder, operating on all four wheels
Size: front 438mm (17¼in) diameter × 102mm (4in) wide, rear 406mm (16in) diameter × 89mm (3½in)
Parking: Rockwell standard drum, mechanically actuated, engagement automatically shifts transmission to neutral
Size: 254mm (10in) diameter × 38mm (1½in)

Electrical system

Type 24V negative earth, two batteries 12V/125A (10h rating)

Hydraulic system

Total capacity 150 litres (33gal), all piston rods chrome-plated
Lift cylinders (2) double acting 152mm (6in) diameter
Dump cylinders (2) double acting 140mm (5½in) diameter
Clam cylinders (2) double acting 102mm (4in) diameter
Steering cylinders (2) double acting 76mm (3in) diameter
Bucket pump: gear type three-stage 265 litres/min (70gal/min) at governed engine speed
Steering pump: gear type, 68 litres/min (18gal/min) with demand valve interconnected to bucket hydraulic system
Control valves: three-spool for loader hydraulic and winch control, two-spool for trailer attached scraper
Main relief valve 126·5kg/cm² (1800lb/in²)
Filters: Full flow micronic, magnetic, full flow wire mesh and air filter

Winch

TT Boughton Series 2H
Bar drum line pull and speed 11 884kg (62 200lb) at 9m/min (30ft/min)
Rope length 46m (150ft), rope diameter 19mm (¾in)

Bucket

Drott 4 in 1 multipurpose SAE rating 1·91m³ (2½yd³)
Rated carrying capacity 4082kg (9000lb)
Maximum lifting capacity to full height 5443kg (12 000lb)
Tipping load 9298kg (20 500lb)
Maximum breakout force, boom lift 8618kg (19 000lb); crowd 14061kg (31 000lb)
Lifting time to full raise 6·5sec, from full raise 4·2sec

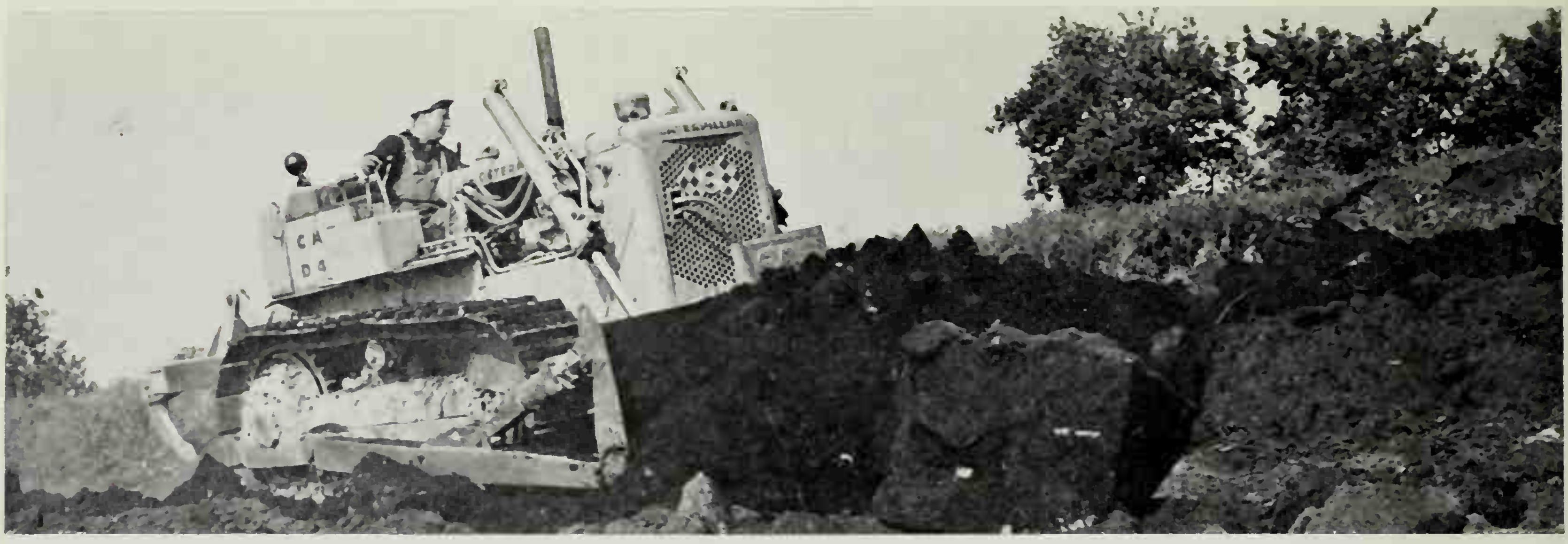
Weights

Front axle 6001kg (13 230lb)
Rear axle 6386kg (14 300lb)
Total (less operator) 12 487kg (27 530lb)

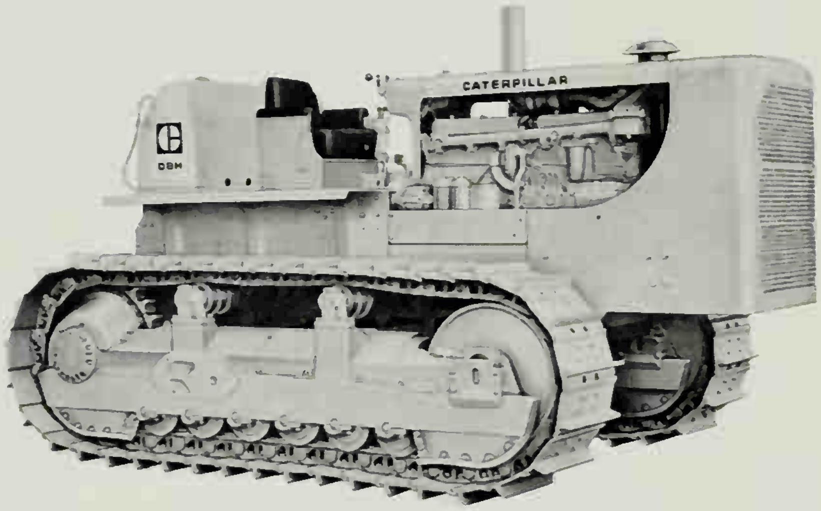
General

Full lighting equipment with two rear-facing headlamps, inter-vehicle starting socket. Connections for trailer equipment. Front and rear windscreen motors. Swivel-type tow hook. Detachable tow hook suitable for scraper. Tyre inflator

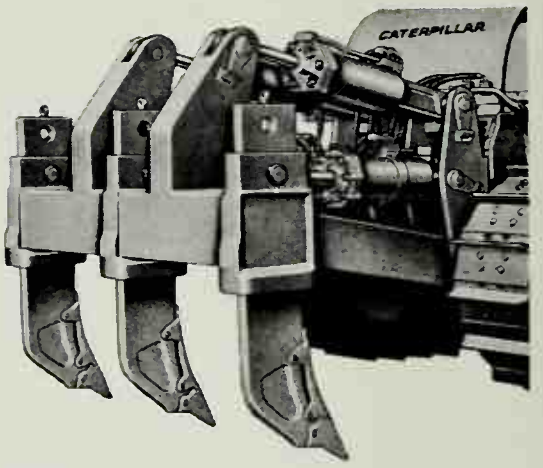
ALLIS-CHALMERS GREAT BRITAIN LTD
Essendine, Stamford, Lincolnshire, England
Telephone: Stamford 2471 Cables: Gyrating Stamford Telex: 32255



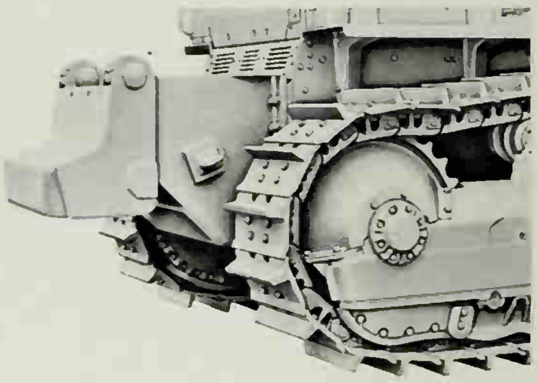
Caterpillar D4D at work in heavy soil with bulldozer attachment



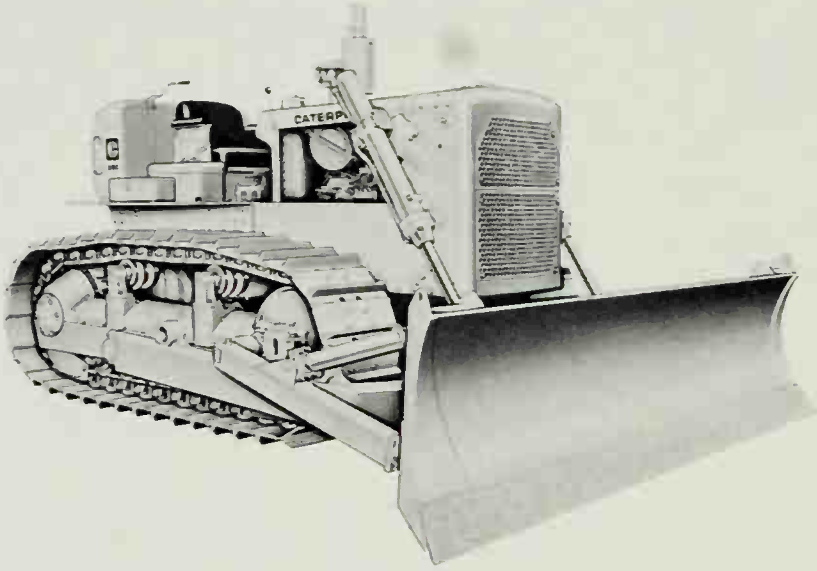
Caterpillar D8H with turbocharged engine delivering 270 bhp net at 1280 rev/min, giving a drawbar pull of nearly 50 tons at lowest speed and a maximum speed of over 10 km/h (6·5 mph) unloaded



Hydraulically adjustable multi-shank ripper attachment on D8H



Cushioned rear push block attachment on D8H



D6C fitted with angle dozer blade with hydraulic rams. The engine delivers 125 bhp net at 1900 rev/min, giving a drawbar pull of over 20 tons at lowest speed. Maximum speed is nearly 11 km/h (7 mph)

Caterpillar 621 wheel tractor-scraper operating in coarse sand

Tractors and scrapers

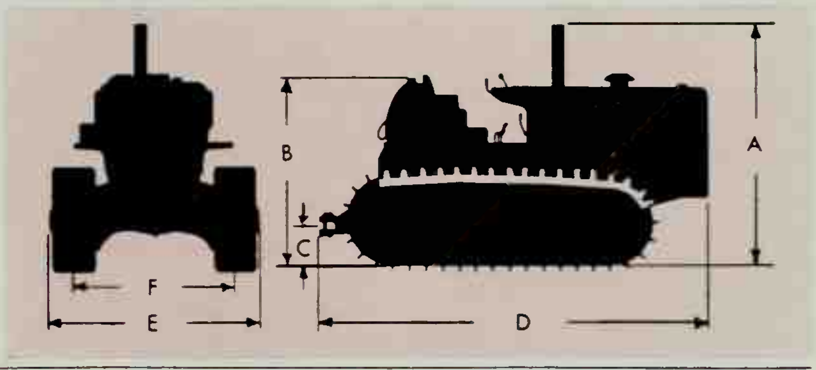
Caterpillar-built equipment

Of the wide range of earthmoving equipment made by Caterpillar, only a very small selection is shown here.

The tractors, ranging from 65 to 385 bhp net, can be adapted to a variety of needs with a wide range of attachments.

The sealed track is specially designed by Caterpillar and extends the normal life of pins and bushings by up to 30%. Track rollers, carriers and idlers are lubricated for life. On the D6C and D8H models the sprockets have bolt-on replaceable rim segments, so that the sprockets can be re-rimmed in the field without dismantling track, sprocket or frame. The track guides have replaceable wear strips.

The 621 wheel tractor-scraper, smallest in the range of high-speed hauling units, incorporates Caterpillar's Low Bowl design for increased capacity and speed in loading. Bowl and tractor can be transported separately.



TRACTOR MODEL		D4D		D6C		D8H
Caterpillar engine type		D330 diesel 4-cyl, 7-litre 65 bhp net at 1680 rev/min		D333 diesel 6-cyl, 10·5-litre 125 bhp net at 1900 rev/min		D342 diesel 6-cyl, 20·4-litre 270 bhp net at 1260 rev/min turbocharged
Transmission		direct drive	power shift	direct drive	full power shift	full power shift (direct drive not available)
Max speeds (forward)						
1st gear	km/h (mph)	2·7 (1·7)*	3·2 (2·0)	2·4 (1·5)	3·7 (2·3)*	0–3·9 (0–2·4)
2nd gear	km/h (mph)	3·9 (2·4)	5·8 (3·6)	3·4 (2·1)	6·6 (4·1)	0–6·8 (0–4·2)
3rd gear	km/h (mph)	5·5 (3·4)	9·3 (5·8)	4·8 (3·0)	10·3 (6·4)	0–10·5 (0–6·5)
4th gear	km/h (mph)	7·1 (4·4)	—	6·8 (4·2)	—	—
5th gear	km/h (mph)	9·3 (5·8)	—	9·5 (5·9)	—	—
Max drawbar pull (forward)						
1st gear	tons	6·3*	17	15·3	22·5	0–49†
2nd gear	tons	4·3	9	10·3	13·5	0–27
3rd gear	tons	3·0	5	6·9	8·5	0–16
4th gear	tons	2·2	—	4·5	—	—
5th gear	tons	1·6	—	2·8	—	—
Track						
Number of shoes (each side)		35		36		39‡
Width of track	mm (in)	330 (13)		455 (18)		560 (22)
Length of track (on ground)	mm (in)	1840 (72½)		2370 (93¼)		2900 (115)
Ground contact area	m² (in²)	1·22 (1885)		2·17 (3357)		3·26 (5049)
Track adjustment		mech. or hydraulic		hydraulic		hydraulic
Steering		mechanical		hydraulic		hydraulic
Dimensions (see sketch)						
Overall height A	mm (in)	2410 (95)		2700 (106)		3100 (122)
Height to fuel filler cap B	mm (in)	1710 (67½)		2120 (83½)		2440 (96)
Drawbar height C	mm (in)	380–475 (15–18¾)		415–500 (16¼–19¾)		530 (21)
Overall length D	mm (in)	3400 (133)		3950 (156)		5200 (204)
Overall width E	mm (in)	1980 (78)		2370 (93)		2700 (107)
Width of track centres F	mm (in)	1520 (60)		1880 (74)		2130 (84)
Ground clearance	mm (in)	355 (14)		370 (14⅝)		510 (19⅞)
Shipping weight	kg (lb)	5900 (13 100)	6200 (13 700)	10 400 (23 000)	10 700 (23 500)	22 700 (50 000)

*Other transmissions are available as standard options †A direct-drive transmission is available as standard option

‡These figures refer to the model with six-roller frame; a seven-roller frame is available as standard option

Type 621 wheel tractor-scraper

Tractor

Caterpillar engine: D336 diesel V8 11·5-litre 300 bhp net at 2200 rev/min

Transmission: 8-speed and reverse mechanical gearbox with torque converter on 1st and 2nd (optional semi-automatic for 3rd to 8th)

Tyres: 26·5 × 29 (wider 29·5 × 29 optional)

Scraper

Capacity: 15·3 m³ (20 yd³) heaped, 10·7 m³ (14 yd³) struck, SAE

Max depth of cut: 330 mm (13 in)

Width of cut: 3000 mm (119 in)

Max penetrating force: 12 900 kg (28 400 lb)

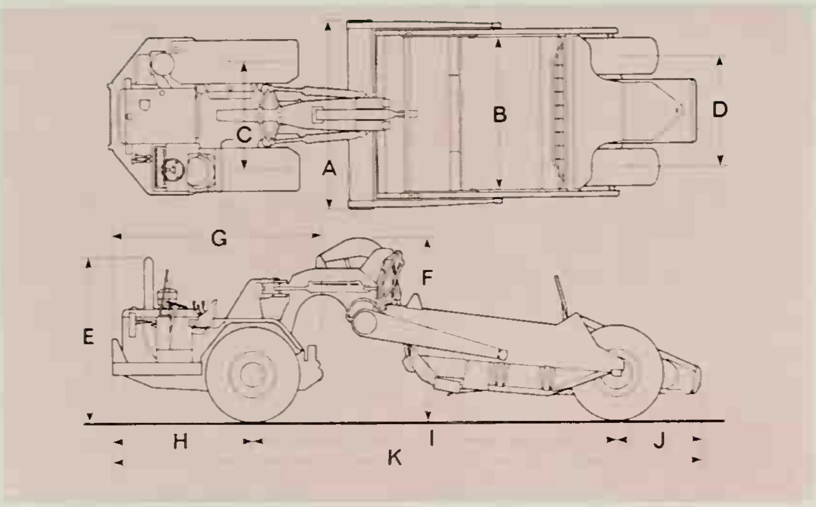
Max depth of spread: 430 mm (17 in)

Controls: hydraulic, from tractor

Dimensions

A 3550 mm (139 in)
B 2950 mm (116 in)
C 2110 mm (83 in)
D 2080 mm (82 in)
E 3050 mm (120 in)
F 3400 mm (134 in)
G 4100 mm (162 in)
H 2750 mm (108 in)
I 7100 mm (281 in)
J 1730 mm (68 in)
K 11 600 mm (457 in)

Weight: 23 600 kg (52 000 lb) empty, 45 400 kg (1000 00 lb) with average load



CATERPILLAR TRACTOR CO LTD

55 St James's Street, London SW1, England

Telephone: 01-493 1882 Cables: Caterpillar London SW1 Telex: 262931

CATERPILLAR

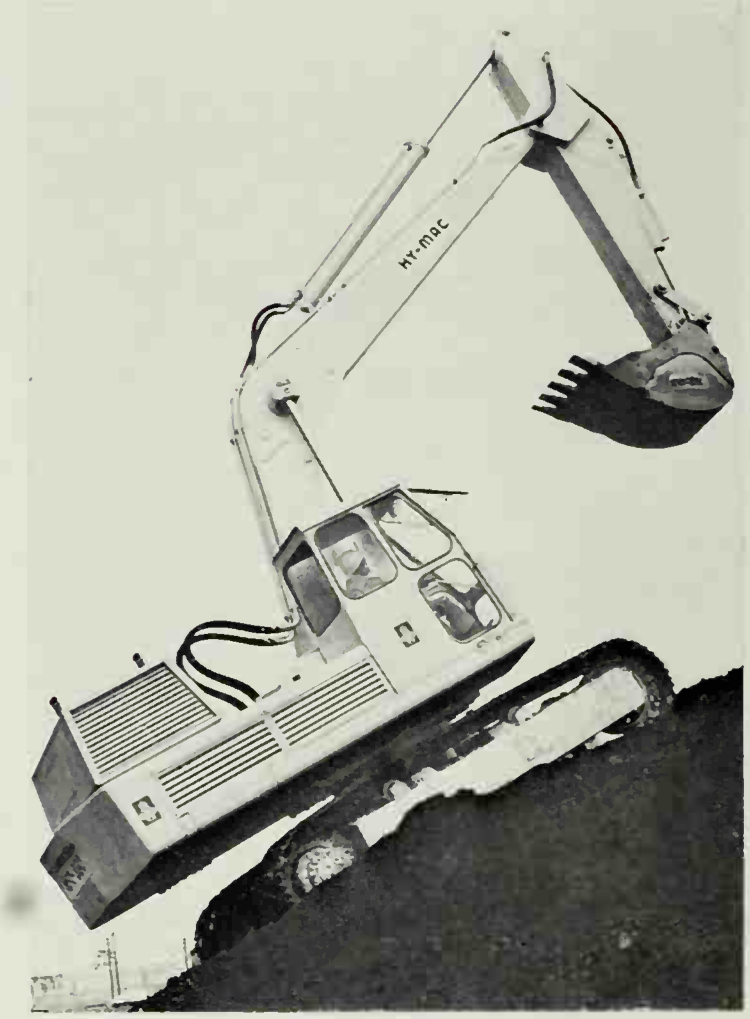
1967

HY-MAC
HY-MAC

The Hy-Mac 580BT excavator with standard back-acter bucket, shown here in British Army colour specification

The Hy-Mac 1080 is amply powered to work a 1 m³ (1¼ yd³) bucket, or (as illustrated) a 1·2 m³ (1½ yd³) face shovel

The wheel-mounted Hy-Mac 610C can be supplied not only with digging grabs and buckets, but also with a variety of special materials-handling grabs



The Hy-Mac 880 can travel on a gradient of 1 in 2 and operate continuously on a gradient of 1 in 4

Construction equipment

Excavators, cranes and materials-handling units

In 1962, Hy-Mac introduced the first all-hydraulic crawler excavator to be made in Great Britain. Now the range of Hy-Mac products embraces all-hydraulic excavators, materials handling equipment and inspection platforms, as well as Hy-Lift cranes.

These products have been found widely acceptable in many countries of the world, even in extreme climates and difficult ground conditions; a large number of Hy-Mac 580BT excavators is now in service with the British Army.

At every stage of production, from design to final inspection, special attention is devoted to reliability and durability. There is a world-wide network of distributors, with experienced servicing staff and Hy-Mac parts stocks, to guarantee after-sales service when required.

An important feature of all Hy-Mac machines is that controls are grouped and placed functionally, so that untrained operators can be quickly taught, and operator-error and fatigue are kept to a minimum.

Excavators

The main machines in the excavator range are:

Hy-Mac 580C
Outreach: 9·09 m (29 ft 10 in)
Digging depth: 6·48 m (21 ft 1 in)
Capacity: up to 700 litres (0·87 yd^3 SAE rating)
Engine: 95 bhp at 2250 rev/min

Hy-Mac 880
Outreach: 10·26 m (33 ft 8 in)
Digging depth: 7·93 m (26 ft)
Capacity: up to 1200 litres ($1\frac{1}{2}$ yd^3 SAE rating)
Engine: 145 bhp at 2600 rev/min

Hy-Mac 1080
Outreach: 11·28 m (37 ft)
Digging depth: 7·32 m (24 ft)
Capacity: up to 1200 litres ($1\frac{1}{2}$ yd^3 SAE rating)
Engine: 164 bhp at 2100 rev/min

Hy-Mac 1290
Outreach: 12·73 m (41 ft 9 in)
Digging depth: 8·69 m (28 ft 6 in)
Capacity: up to 1200 litres ($1\frac{1}{2}$ yd^3 SAE rating)
Engine: 190 bhp at 2100 rev/min

Hy-Mac 610C
(with back-acter equipment)
Outreach: 8·86 m (29 ft 1 in)
Digging depth: 6·17 m (20 ft 3 in)
Capacity: up to 700 litres (0·87 yd^3 SAE rating)
Engine: 95 bhp at 2250 rev/min

Hy-Mac 610C
(with actuated grab)
Outreach: 7·65 m (25 ft 1 in)
Digging depth: 6·60 m (21 ft 8 in)
Capacity: up to 700 litres (0·87 yd^3 SAE rating)
Engine: 95 bhp at 2250 rev/min

Front end equipment: the Hy-Mac range of special equipment is wide and includes varied types of buckets, grabs, face shovels and extended dipper arms.

Cranes

Hy-Mac also manufactures the range of Hi-Lift cranes. The main models are:

Hy-Lift HM300
Truck-mounted telescopic crane
Height of lift: 20·42 m (67 ft)
Maximum load: 10 161 kg (10 tons)

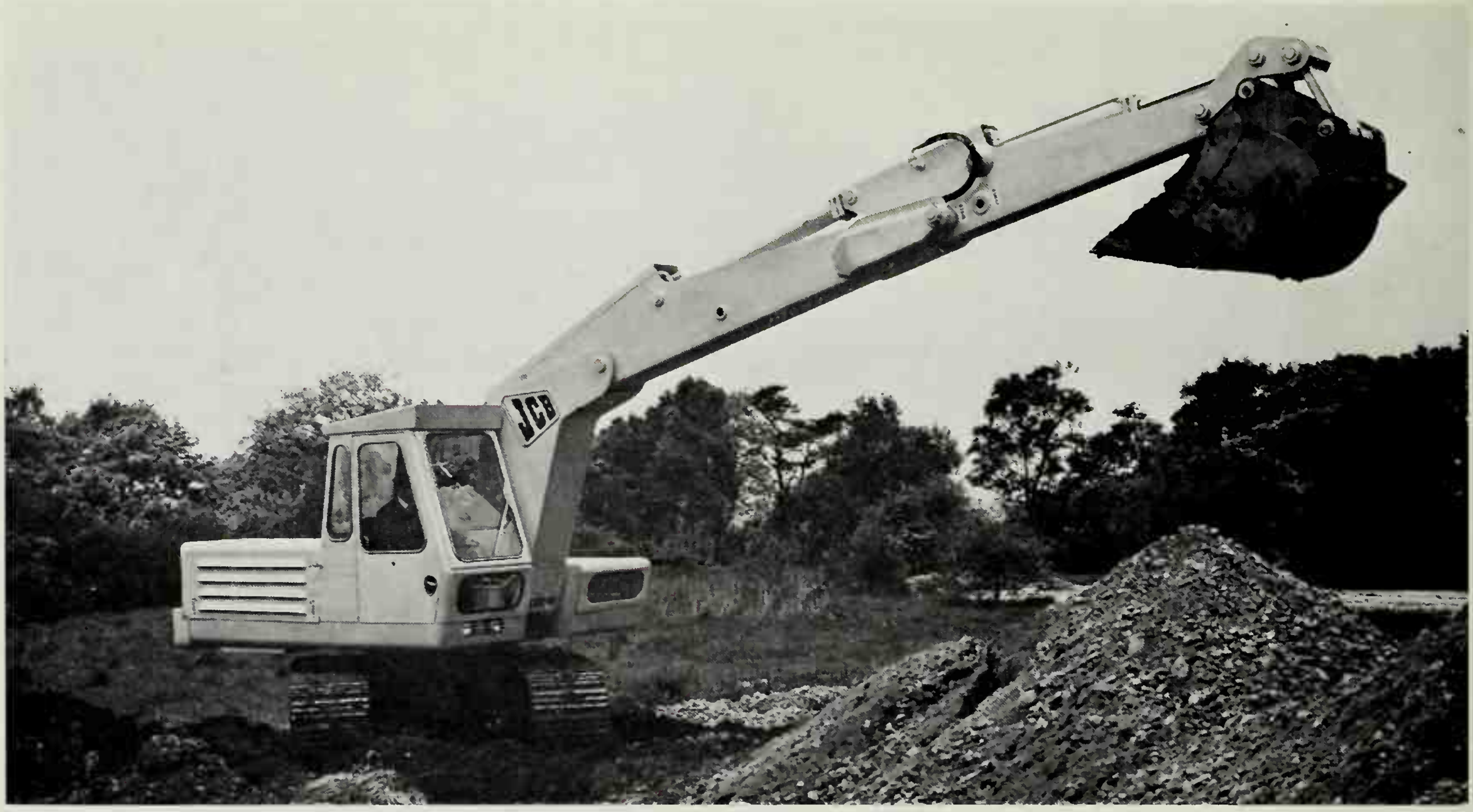
Hy-Lift HM675
Self-propelled telescopic crane
Boom extension (with manual stage) to: 10·36 m (34 ft)
Maximum load: 6096 kg (6 tons)

Hy-Lift HM1150
All-hydraulic crawler crane
Maximum boom length: 42·67 m (140 ft)
Fly jib also available
Maximum load: 40 642 kg (40 tons)

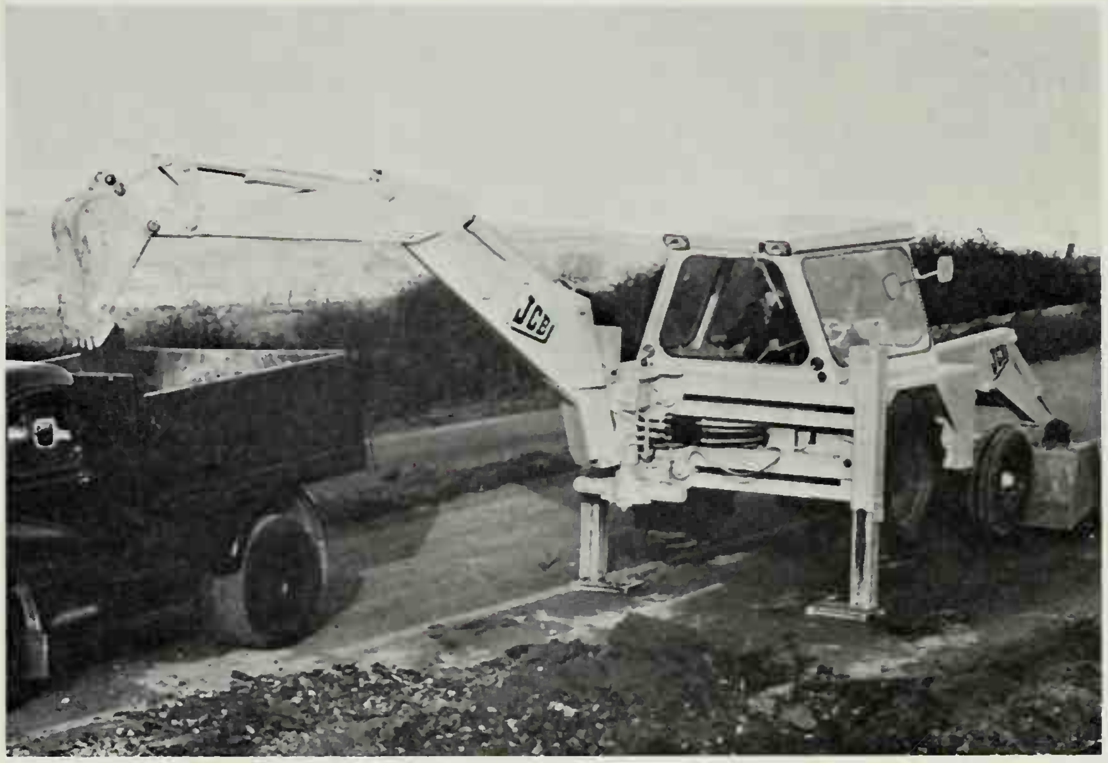
A Powell Duffryn Company
HY-MAC LIMITED
Hy-Mac House, Bath Road, Newbury, Berkshire, England
Telephone: Newbury 2205 Cables: Hymac Newbury Telex: 84557

HY-MAC

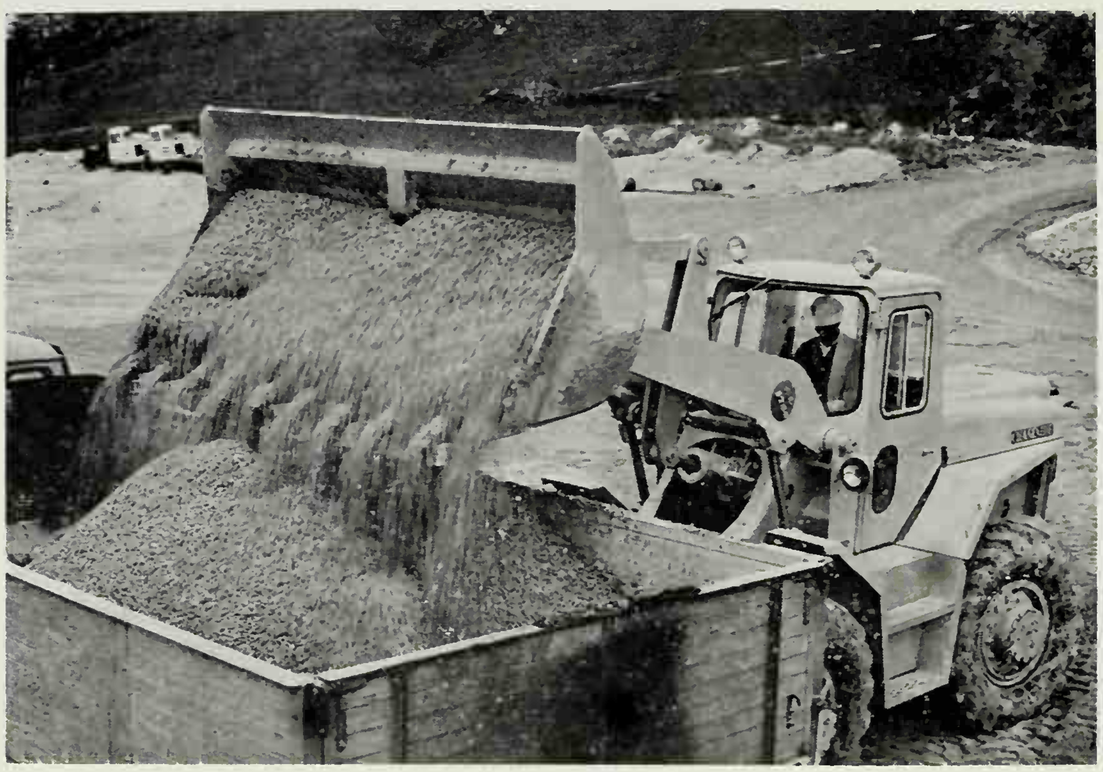
1968



A JCB 7B tracked excavator, demonstrating the straight-arm geometry of the boom and dipper, which gives it a load over height of 5·54 m (18 ft 2 in), a digging depth of 6·10 m (20 ft) and a reach of 9·30 m (30 ft 6 in). The 7B has a bucket capacity rated at 0·67–0·76 m^3 ($\frac{7}{8}$–1 yd^3)



The versatile JCB 3C, job-proven for reliability, is the most popular wheeled excavator/loader in the UK. The famous, ergonomically designed JCB cab offers the optimum in all-round visibility, simplicity of controls and operator comfort



Speedy, tough and economical, the JCB 1750 is one of a range of eight-wheeled loading shovels, offering high economic performance for a wide variety of bulk materials handling applications. The JCB 1750 has a rated payload of 3175 kg (7000 lb) and is powered by a Leyland 138 hp engine with Clark transmission

Excavators

loaders and shovels

A wide range of earthmoving equipment to suit most needs is made by JCB and available from JCB Sales Ltd, backed by a world-wide parts and repair service. Brief details only of some of the most popular machines are given here.

The hydraulic systems of all machines have been developed over nearly 20 years to a high pitch of efficiency as the result of experience gained in operation in all parts of the world, under all kinds of climatic conditions. Servicing requirements have been reduced to a minimum and the entire range enjoys a high degree of interchangeability of components.

Controls, too, have been kept simple, to enable personnel with a minimum of training to operate the machines efficiently.

JCB tracked excavators

A range of machines of popular size capable of big performance. Important features are superior lift capacity, bucket crowd action and tear-out force.

JCB tracked excavators have 360° of continuous slew and incorporate a revolutionary two-step hydraulic system which directs maximum power and speed to where and when needed for fast and efficient working cycles.

JCB 5C
Engine: 77bhp at 2250rev/min
Digging depth: 5·76m (18ft 11in)

JCB 6C
Engine: 106bhp at 2250rev/min
Two-position boom and dipper
Digging depth: 6·35m (20ft 10in)

JCB 6D
Engine: 106bhp at 2250rev/min
Two-position boom and dipper
Chain-type running gear
Digging depth: 6·35m (20ft 10in)

JCB 7B
Engine: 106bhp at 2250rev/min
Digging depth: 6·1m (20ft)
Chain-type running gear

JCB 7C
Engine: 106bhp at 2250rev/min
Two-position boom and dipper
Chain-type running gear
Digging depth: 6·73m (22ft 1in)

JCB wheeled excavator/loaders

Highly versatile machines of rugged construction which have, as standard, the most luxurious, ergonomically designed cab on the market. All backacter positions can be controlled from the cab. Controls are simple and within easy reach whether the operator is facing front, rear or is standing.

JCB 2B
Engine: 70bhp at 2200rev/min
Snap-mount backhoe
Digging depth: 3·25m (10ft 8in)

JCB 3
Engine: 70bhp at 2200rev/min
Digging depth: 3·70m (12ft 2in)

JCB 3C
Engine: 70bhp at 2200rev/min
Digging depth: 4·19m (13ft 9in)

JCB 3D
Engine: 70bhp at 2200rev/min
Digging depth: 4·60m (15ft 1in)

JCB 4D
Engine: 70bhp at 2200rev/min
Digging depth: 4·95m (16ft 3in)

JCB loading shovels

A choice of machines with two-wheel or four-wheel drive, with payloads ranging from 1600 to 5000 kg (3500 to 11 000 lb). Patented three-ram geometry gives ideal bucket-carrying positions and permits a design of great stability with excellent visibility and low fuel consumption. The combination of modern functional design and job-proven components results in a range of machines capable of extremely high economic performance.

JCB 704
Drive: four wheels
Engine: 90hp SAE gross
Payload: 1590 kg (3500 lb)

JCB 702
front wheels only

JCB 1000
Drive: four wheels
Engine: 131hp SAE gross
Payload: 2150 kg (4750 lb)

JCB 900
front wheels only

JCB 1750
Drive: four wheels
Engine: 151hp SAE gross
Payload: 3180 kg (7000 lb)

JCB 907
front wheels only

JCB 3000
Drive: four wheels
Engine: 224hp SAE gross
Payload: 5000 kg (11 000 lb)

The loading shovels, developed from the JCB 2 and JCB 3 machines, are outstandingly versatile. The wide range of attachments includes: bulldozer blade, lifting forks, crane jib of one ton capacity, scarifier, pole erector or tree planter, 4-in-1 shovel, loader, grab and many others.

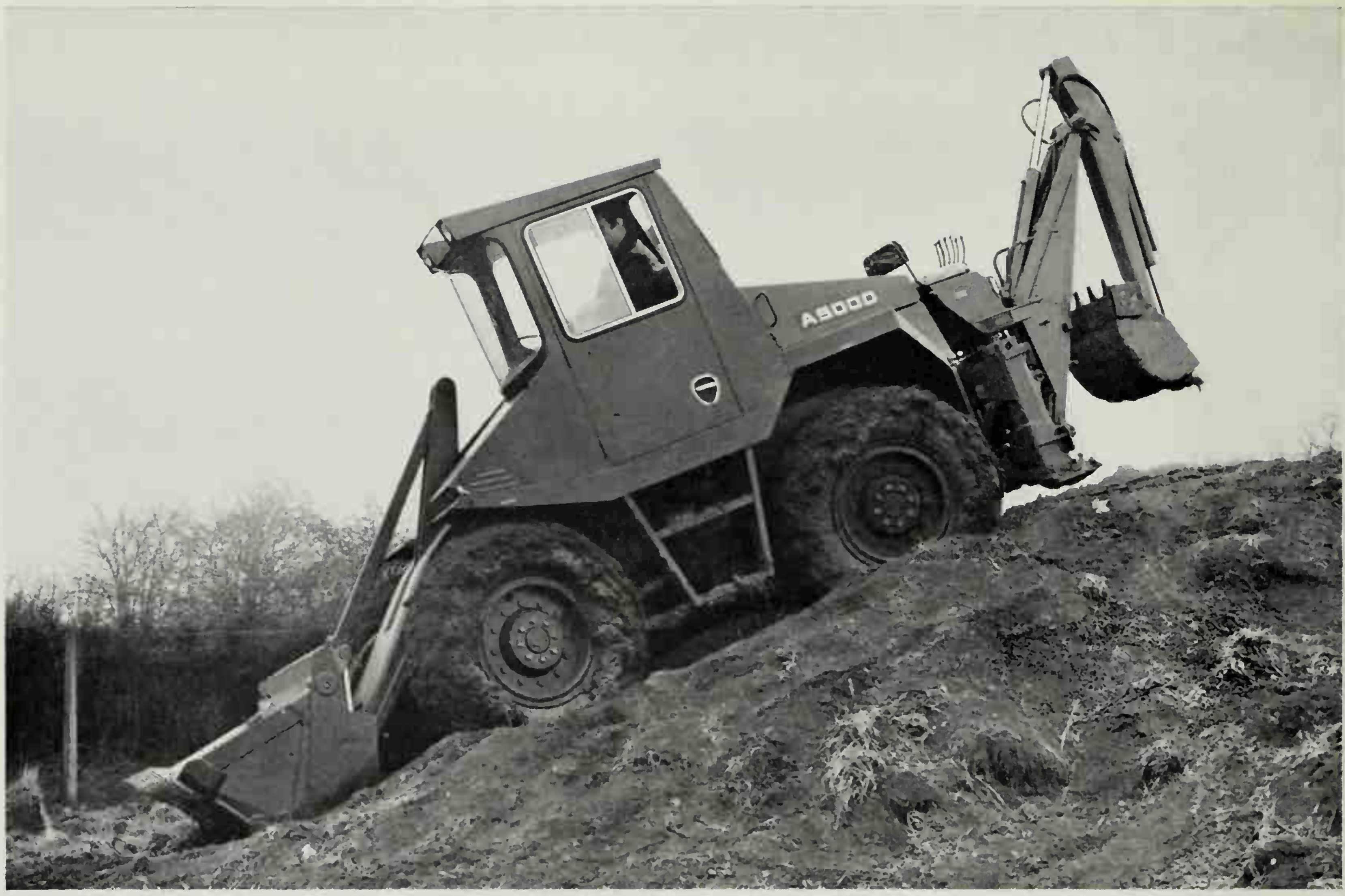
JCB 700
Engine: 70bhp
Capacity: 0·91m^3 (1 ⅕yd^3)

JCB 2BS
Engine: 70bhp
Capacity: 0·57m^3 (¾yd^3)

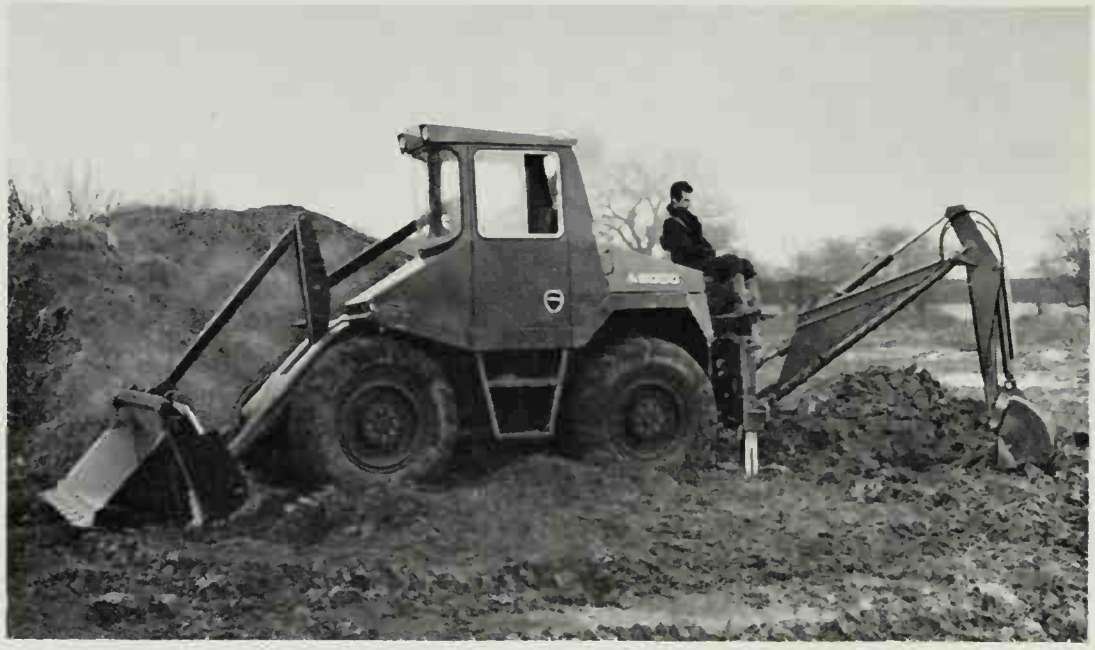
JCB 3S
Engine: 70bhp
Capacity: 0·57m^3 (¾yd^3)

JCB 3CS
Engine: 70bhp
Capacity: 0·77m^3 (1yd^3)

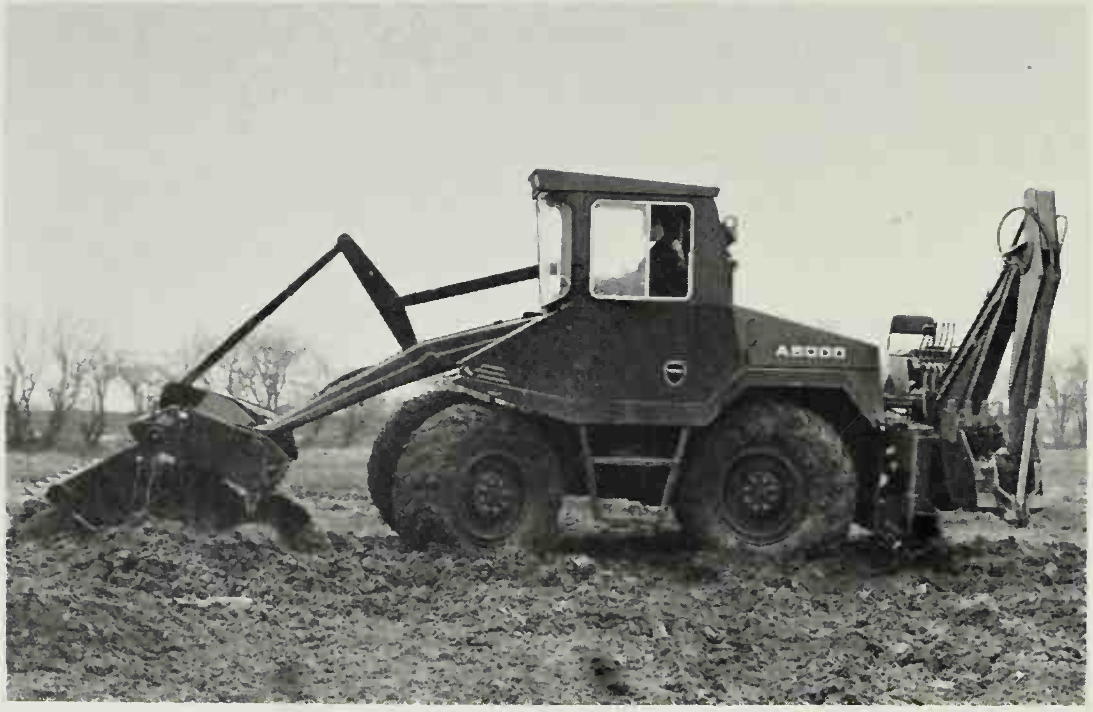
JCB SALES LIMITED
Rocester, Uttoxeter, Staffordshire, ST14 5JP, England
Telephone: Uttoxeter 3121 Cables: Earthmover Uttoxeter Telex: 36154



Above: Muir-Hill A5000 all-wheel-drive, all-wheel-steer loading shovel with 4-in-1 bucket and rear-mounted trenching attachment



Digging with the rear-mounted trencher. The operator sitting over the boom has the advantage of perfect visibility even in the most awkward spaces

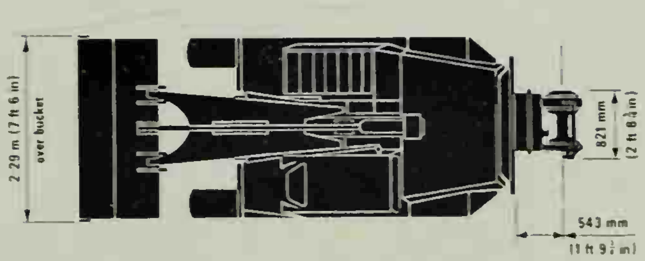


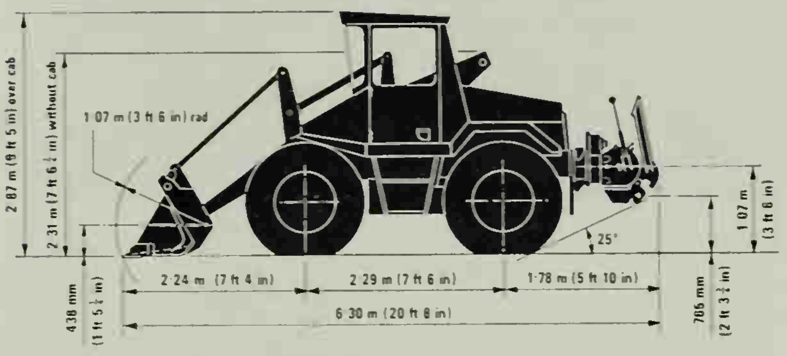
The 4-in-1 bucket clamshelling the last of the pile. In addition to operating conventionally, this bucket bulldozes and scrapes

Bucket loader

Multi-purpose military loading shovel

The Muir-Hill A5000 all-wheel-drive, all-wheel-steer loading shovel has been specially prepared for military application.





Specification

Overall dimensions
Overall height with cab: 2·87 m (9 ft 5 in); without cab: 2·30 m (7 ft 6¾ in)
Width over tyres: 2·16 m (7 ft 1¼ in)
Max width overall: 2·29 m (7 ft 6 in) approx (over bucket)
Length: bucket on ground: 6·30 m (20 ft 7⅝ in) over sprag in carry post; bucket at carry: 6·30 m (20 ft 7⅝ in)
Wheelbase: 2·29 m (7 ft 6 in)
Track: 1·77 m (5 ft 9½ in)
Ground clearance: 419 mm (1 ft 4½ in)
Approach angle: 90°
Departure angle: 25° with winch
Height of towing hooks: 705 mm (2 ft 3¾ in) with winch

Weights
Axle loads, with full fuel, oil and water, with cab, bucket and winch:
  Front axle: 3402 kg (7500 lb)
  Rear axle: 4921 kg (10 850 lb)

Tyres
Size: 15·5 × 25–12 PR
Tread: Dunlop EM 11
Pressure: Front 2·5 kg/cm² (35 lb/in²)
  Rear 1·8 kg/cm² (25 lb/in²)

Draw bar pull
1st and 2nd gear: 12 927 kg (28 500 lb) available, limitation on weight of vehicle ie U = 0·75 on unladen vehicle = 5987 kg (13200 lb)
3rd and 4th gear: travelling range 3992 kg (8800 lb)

Engine
Perkins diesel, 4-stroke
Model: 6·354
Horsepower: 104 at 2500 rev/min governed speed
Bore: 984 mm (3·875 in)
Stroke: 127 mm (5 in)
Displacement: 5800 cm³ (354 in³)
Fuel tank capacity: 182 litres (40 gal)
Cooling system capacity: 29·6 litres (6·5 gal)
Air cleaner: Coopers 8-in Cyclopac with restriction indicator
Cold starting device: Start Pilot
Oil-filter: full-flow type

Transmission
Torque converter: Allison TT2220–1 Torqmatic Hydropowershaft direct-mounted to engine by Flexplate coupling. Single-lever control. Full powershift between work and travel ranges. Torque multiplication 5·1:1

Steering
Hydraulically assisted by direct-driven vane pump
Min turning circle:
  1) Radius to inside: 1·83 m (6 ft 0 in)
  2) Radius to outside of bucket: 4·70 m (15 ft 5 in)

Bucket equipment
SAE capacity: 0·75 m³ (1 yd³) struck; 1 m³ (1¼ yd³) heaped
Lifting capacity (rated): 2268 kg (5000 lb) payload
Max lifting capacity to full height of lift: 4082 kg (9000 lb)
Max break-out force:
  1) Boom lift: 4536 kg (10 000 lb)
  2) Crowd: 5897 kg (13 000 lb)
Width outside: 2·29 m (7 ft 6 in)
Max dumping height: 3·00 m (9 ft 10 in)
Max load-over height: 3·57 m (11 ft 8½ in)
Angle of dump: 45°
Raising times to max height with rated load: 6 sec

Winch
T T Boughton Type 2H
Bare drum line-pull and speed: 9072 kg (20 000 lb) at 7 m/min (23 ft/min)
Rope:
  Length: 91·44 m (300 ft)
  Construction: 6/19 hemp core 17 324/18 898 kgf/cm² (110/120 tons/in²)
  Diameter: 15 mm (⅝ in)
Weight (including rope): 689 kg (1520 lb) approx

Fork lift equipment
Size of forks: 127 mm (5 in) wide
Max and min spacing (centre-to-centre): 1·14 m (3 ft 9 in) max; 152 mm (6 in) min
Max height of lift (forks horizontal and back of forks level with front of tractor): 2·85 m (9 ft 4 in)
Max forward tilt:
  1) At carry position: 10° if level ground, 70° below horizontal if discharging below level
  2) At max height: 43°
Full tilt range (forwards to backwards): 110°
Side shift (each side of central position): 229 mm (9 in)
Capacity at 610 mm (2 ft 0 in) load centre: 1814 kg (4000 lb)
Weight: 590 kg (1300 lb) approx

Back acter
Size of bucket: 610 mm (2 ft 0 in)
Capacity of bucket: 0·12 m³ (4·2 ft³)
Depth of dig: 3·66 m (12 ft 0 in)
Outreach: 4·27 m (14 ft 0 in)
Loading height: 3·48 m (11 ft 5 in)
Slew and digging arc: 193°
Max offset of king post from centre: 711 mm (2 ft 4 in)
Width of stabiliser base 1·63 m (5 ft 4 in)
Weight: 1293 kg (2850 lb)

Crane hook attachment
Capacity: 1814 kg (4000 lb) at 610 mm (2 ft 0 in) outreach; 1588 kg (3500 lb) at 914 mm (3 ft 0 in) outreach

Other products

The A500 is one of a range of nine Muir-Hill loading shovels with payloads from 1800 kg (4000 lb) to 5450 kg (12 000 lb), all featuring the same basic design concepts for increased efficiency. Muir-Hill also produces three heavy-duty four-wheel drive tractors, a range of dumpers with payloads from 5 to 25 tons, and two mobile cranes of 10 tons and 20 tons capacity respectively.

A member of the Babcock & Wilcox Limited Group
MUIR-HILL LIMITED
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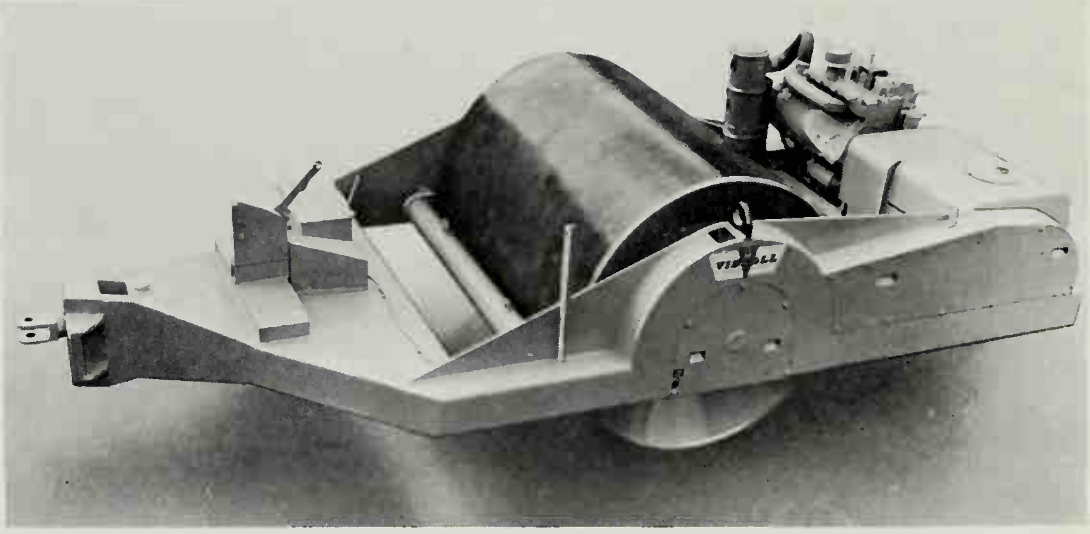
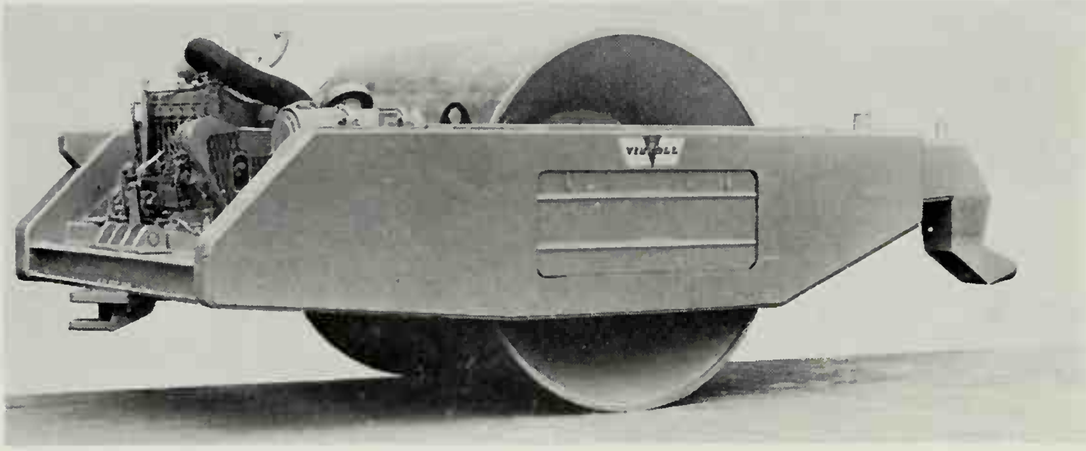
Muir-Hill

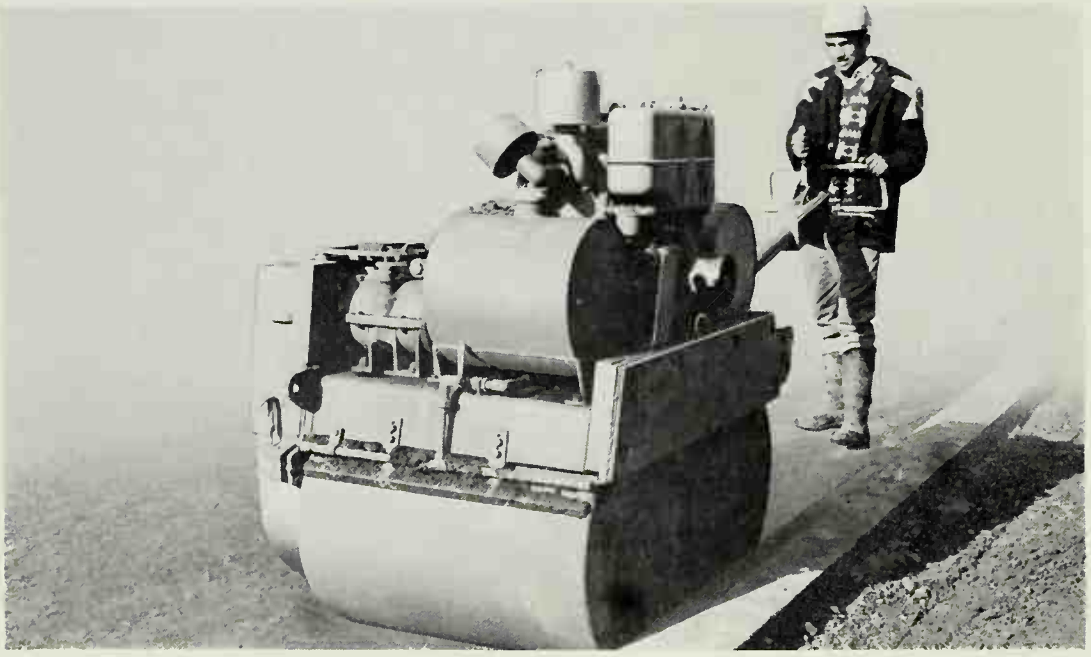
Model 54RD2
Tandem vibrating roller
This roller is equipped with a variable-amplitude system enabling the degree of vibration to be altered to suit the depth of material being rolled. It provides the most efficient compaction ever on a wide variety of soils and materials. Other important features include extra smooth reversal, excellent manoeuvrability, compaction on steep gradients and easy maintenance. Several of these rollers have recently been supplied for use in the construction of airfields and access roads at military installations



Model T182
Trailer vibrating roller
Ideal for large-scale projects, this machine can be towed singly, in tandem, two abreast or chevron formation—a suitably equipped four-wheel drive 65 hp tractor being suitable under most site conditions. Features a totally enclosed vibrator belt drive and self-adjusting clutch. A sheepsfoot conversion is available for clay soils



Model T208
Trailer vibrating roller
The most powerful model in the Vibroll range. Up to 300 tons of impact assures faster, deeper compaction for a wide range of materials in the construction of earth fills, embankments and dams. Handles rock in lifts up to 0·9 m (3 ft)-deep. Heavy-duty frame, extra-capacity fuel tanks, high-yield steel roller and 105 bhp engine are just a few outstanding features. A sheepsfoot conversion is available for clay soils



Model D76
High-frequency, high-output duplex vibrating roller
This model is one of the latest additions to the Vibroll range and is suitable for any surface. The rolls are fixed so that the roller tends to maintain its line giving less operator effort, although the random phasing of the vibration makes it easily steerable when required. Features include 97 percent isolation from vibration, two fast travel speeds, excellent climbing ability and an extremely reliable air-cooled Lister engine. Extra-high kerb clearance and adjustable operator's handle are also important features

Vibrating rollers

for soil compaction and consolidation

The Vibroll range of vibrating rollers was first introduced by Stothert & Pitt in 1945.

The patented vibrating action of the Vibroll system causes the material particles to re-orientate themselves in such a way that voids are kept to a minimum. The action extends to a considerable depth and area around the vibrating roll.

On materials such as non-cohesive soil, sand, wet mix, gravel, etc, the Vibroll has no equal, the re-orientation of material particles ensuring that compaction is particularly good.

Besides the four heavy-duty models from the Vibroll range illustrated here, there is also a wide range of smaller trailer, tandem and pedestrian models, each employing the same Vibroll system.

Specifications

Model 54RD2

Total weight (wet unballasted): 7360 kg (7·30 tons)
Weight on front roll (wet unballasted): 2860 kg (2·82 tons)
Weight on rear roll (wet unballasted): 4610 kg (4·56 tons)
Total weight (fully ballasted): 8570 kg (8·46 tons)
Weight on front roll (fully ballasted): 3970 kg (3·9 tons)
Weight on rear roll (fully ballasted): 4610 kg (4·56 tons)
Width of vibrating roll: 1372 mm (54 in)
Width of steering roll: 1295 mm (51 in)
Diameter of rolls: 1219 mm (48 in)
Wheelbase: 2972 mm (9 ft 9 in)
Overall length: 4451 mm (14 ft 7½ in)
Overall width: 1753 mm (5 ft 9 in)
Overall height (with cab): 2642 mm (8 ft 8 in)
Clearance, travel drive side: 178 mm (7 in)
Clearance, vibrator drive side: 381 mm (1 ft 3 in)
Overhang both sides: 191 mm (7½ in)
Turning circle: 12·8 m (42 ft)
Frequency: 50 Hz
Maximum impact: 55 090 kg (121 450 lb)

Travelling speeds
1st gear: 1·5 km/h (0·9 mph) speed constant
2nd gear: 4 km/h (2·5 mph) speed constant
3rd gear: 5·5–8 km/h (3·5–5·0 mph) (not vibrating, controlled by engine throttle)

Power unit
Lister HA3 3-cylinder air-cooled diesel engine giving 33 bhp at 1800 rev/min (governed speed) with manual control down to idling speed of 900 rev/min. Electric starting
Fuel consumption at full load: 7·73 litres/h (1·7 gal/h)

Model T182

Machine with smooth roll
Overall length: 5048 mm (16 ft 6¼ in)
Overall width: 2261 mm (7 ft 5 in)
Overall height: 1473 mm (4 ft 10 in)
Roll width: 1828 mm (6 ft 0in)
Roll diameter: 1380 mm (4 ft 6 in)
Weight: 5051 kg (4·95 tons)
Vibrator frequency: 34·3 Hz
Maximum impact: 98 474 kg (96·9 tons)

Machine with sheepsfoot roll
Roll diameter: 1475 mm (4 ft 10 in)
Weight: 5607 kg (5·5 tons)
Engine: Lister HA4 4-cylinder diesel, air-cooled, 44 hp at 1800 rev/min (continuous rating BS 649:1958)
Fuel tank capacity: 90 litres (20 gal) (sufficient for 12 hours' operation)
Starting by means of Simms spring starter

Model T208

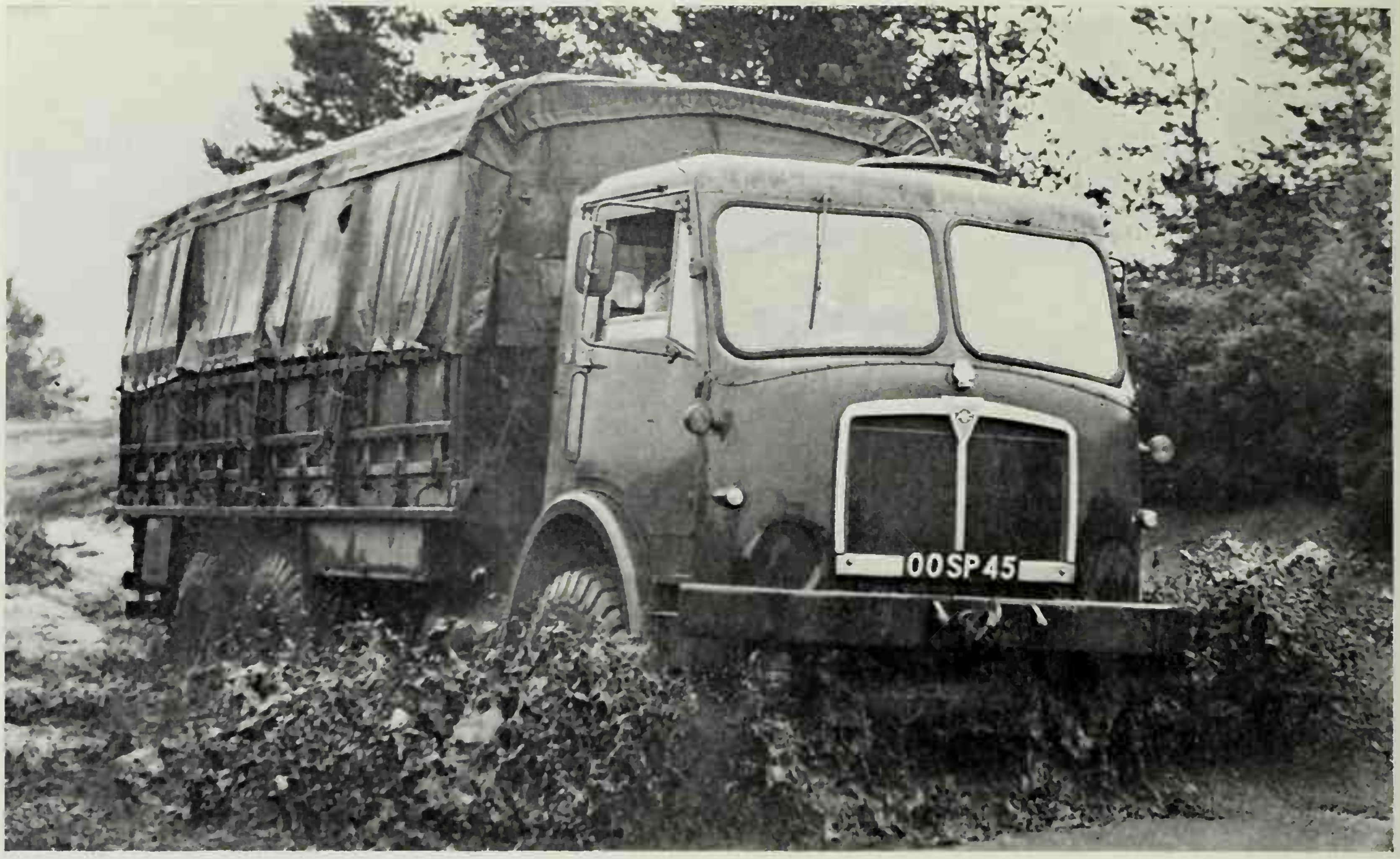
Total operational weight: 11 700 kg (11·5 tons)
Roll diameter: 1828 mm (72 in)
Roll width: 2082 mm (82 in)
Overall length: 5963 mm (19 ft 6¾ in)
Overall width: 2501 mm (8 ft 2⅜ in)
Frequency: 30 Hz
Maximum impact: 306 175 kg (300 tons)
Engine: Lister HR56, 105 hp at 1800 rev/min or Deutz F6L514, 106 hp at 1800 rev/min
Engine speed control: mechanical
Fuel tank capacity: 182 litres (40 gal)

Model D76

Total operational weight: 1134 kg (2500 lb)
Roll width: 762 mm (2 ft 6 in)
Roll diameter: 570 mm (22½ in)
Length overall: 2971 mm (9 ft 9 in)
Length without handle: 1308 mm (4 ft 3½ in)
Width overall: 990 mm (3 ft 3 in)
Height overall: 1295 mm (4 ft 3 in)
Frequency of vibration: 66·6 Hz
Amplitude: 0·40 mm (0·061 in)
Maximum impact (each roll): 9638 kg (9·5 tons)
Engine: Lister diesel SR1, 7·75 hp at 2500 rev/min air-cooled
Speeds: two, forward and reverse 2·88 and 1·42 km/h (1·8 and 0·88 mph)
Fuel tank capacity: 5·5 litres (1·25 gal)
Water tank capacity (2 tanks): 61 litres (13·4 gal)
Water spray on both rolls
Ground clearance—drive side: 76 mm (3 in)
overhang: 141 mm (5·75 in)
Ground clearance—non-drive side: 445 mm (17·5 in)
overhang: 38 mm (1·5 in)

STOTHERT & PITT LIMITED
Construction Equipment Division
PO Box 25, Bath, Somerset, BA2 3DJ, England
Telephone: Bath 63401 Cables: Stothert Bath Telex: 44177

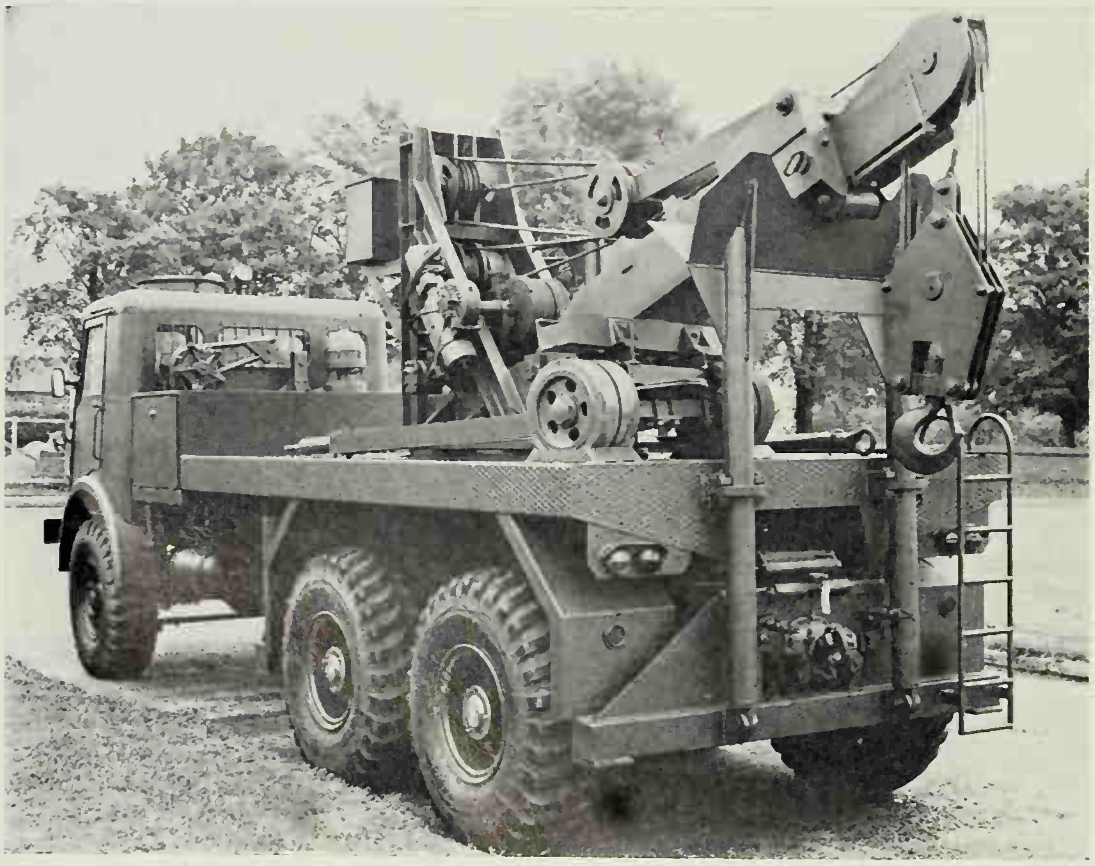
Section 13
Vehicles



The AEC Militant III 10-ton cargo truck on a 6 x 6 chassis

This recovery vehicle has an AEC Militant 10-ton chassis and is fitted with a Renolds Boughton hydraulically operated crane with a manual jib extension mounted on a ballbearing slewing ring giving an angle of slew of 180°. Hydraulic luffing is carried out by the Boughton B19H winch which is fitted with an automatic brake. Hydraulic power is generated by a pump driven from a single-speed power take off which is supplied with the chassis.

The crane's main frame and structure is fabricated from standard road steel sections electrically welded. A load indicator is fitted to the main jib and suitably marked showing safe loads. The crane can lift a maximum weight of 10 tons



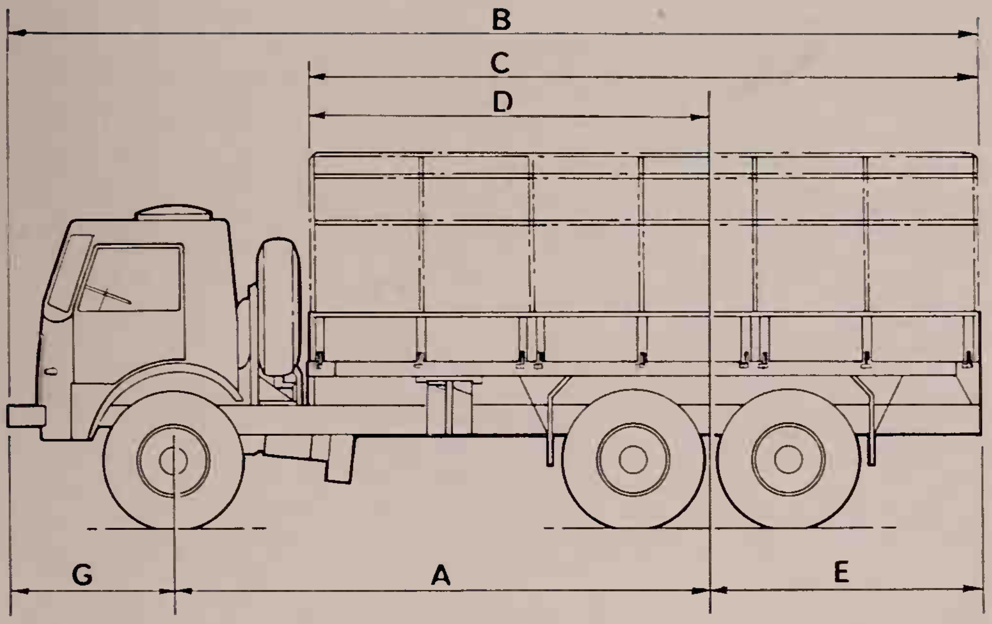
Militant III

10-ton 6 x 6 cargo truck

The Militant has been built to comply with the Fighting Vehicle Research and Development Establishment's specification for a 10-ton general-service cargo vehicle. The design includes current commercial vehicle components adapted as necessary to meet military requirements.

The body has a flat floor and is intended for the carrying of all forms of cargo. To facilitate loading by fork lift truck, the body sides as well as the tail board may be dropped or removed. The vehicle has an average road speed of 53 km/h (33 mph) and a range of action at maximum speed of 480 km (300 miles).

Its robust construction, good road speed and cross-country capability combined with reliability in service and ease of maintenance render the Militant III an outstanding vehicle for military purposes.



Dimensions

- **A** Wheelbase: 4877 mm (16 ft)
- **B** Overall length: 8798 mm (28 ft 10⅜ in)
- **C** Body length: 6153 mm (20 ft 2¼ in)
- **D** Body to centre line of bogie: 3702 mm (12 ft 1¾ in)
- **E** Rear overhang: 2451 mm (8 ft ½ in)
- **G** Front overhang: 1470 mm (4 ft 9⅞ in)

Specification

Performance
Weight: unladen 11 850 kg (26 104 lb); gross 22 000 kg (48 504 lb)
Average max speed: on road 53 km/h (33 mph); cross-country 24 km/h (15 mph)
Range at average max road speed: 480 km (300 miles)
Gross power-to-weight ratio: 10 bhp/ton
Max tractive effort, low gear: 544 kg/ton (1200 lb/ton)
Max climbing ability: 1 in 3
Max gradient for stop/start: 1 in 3

Engine
Type: AEC AV760 diesel
Displacement: 12·473 litres (761 in^3)
Output: 201 bhp at 2000 rev/min (B.S.AU 141: 1967)
204 bhp at 2000 rev/min (DIN 70020)
Torque: 79·3 kgf m (571 lbf ft) at 1500 rev/min (B.S.AU 141: 1967)
Governed speed: 2000 rev/min
Ignition type: compression

Fuel system
Type: lift pump
Type of fuel: diesel
Air cleaner: oil bath
Fuel capacity: 218 litres (48 gal)

Transmission
Clutch: single dry plate
Gearbox: 6-speed constant mesh
Transfer box: 2-speed
Transfer box ratios: 1:1 and 1·634:1
Axle type: fully floating
Overall ratios: top 7·9:1, bottom 91·5:1
Number of differentials: three

Electrical system
Voltage: 24 V
Wiring: insulated return
Type of alternator: 127 mm (5 in) dia, 25 A
Capacity of batteries: 100 Ah
Water-proofing, tropicalisation and suppression: to FVRDE Spec 2051 Appendix D1, Sched B

Steering
Type: worm and nut, hydraulic assistance
Turning circle: right-hand 22·9 m (75 ft); left-hand 27·9 m (75 ft)

Wheels
Rims: WD divided disc
Tyres: 14·00 × 20 in cross-country, or 15·00 or 16·00 × 20 in on four-piece discs

Brakes
Foot: two-line air pressure, dual circuit
Hand: air-assisted mechanical on four rear wheels
Warning devices: buzzer and gauge

Suspension
Type: front semi-elliptic springs; rear semi-elliptic springs inverted
Shock absorbers: front only

Military characteristics
Roles: transportation of cargo including NATO palletised loads
Cargo capacity of load deck: 212 m^3 (277 yd^3)
Towing ability: front hook, rear hook

Variants of basic chassis
Fueller/tanker, command vehicle, tractor, recovery vehicle, tipper

AEC LIMITED
Military Sales Division
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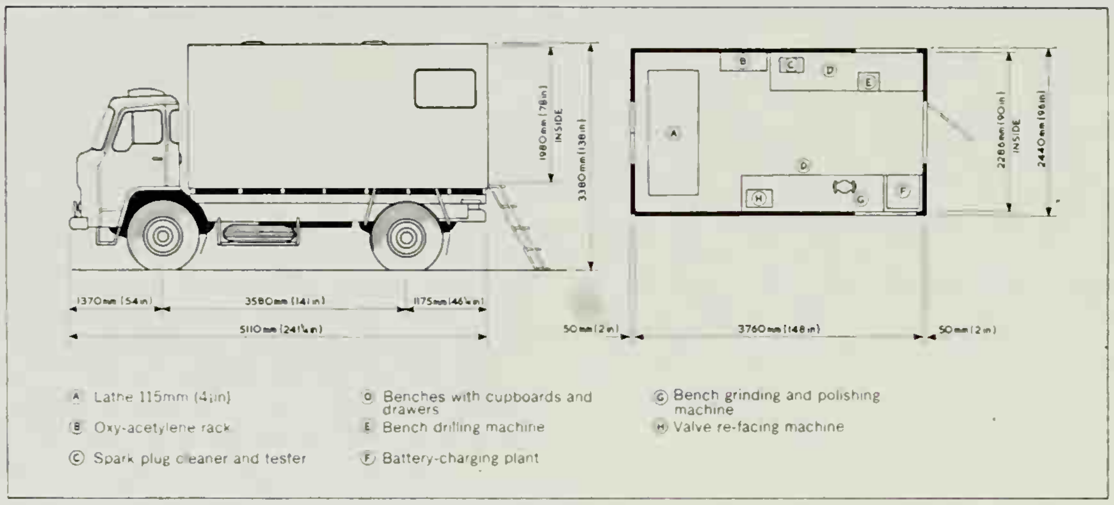
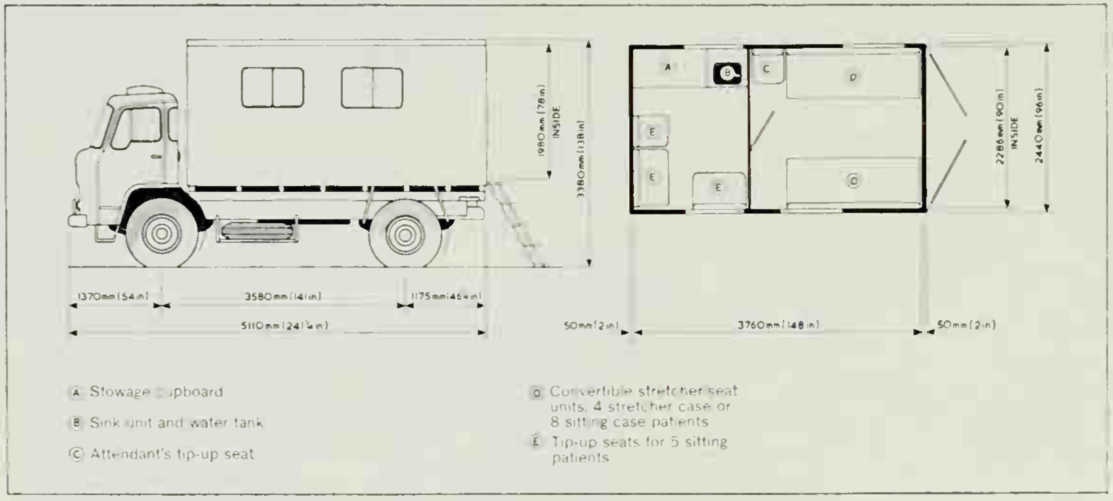
BRITISH
LEYLAND


1980mm (78 in)
INSIDE
3380mm (133 in)
2286mm (90 in)
INSIDE
2440mm (96 in)
1370mm (54 in)
3580mm (141 in)
1175mm (46¼ in)
5110mm (241¼ in)
50mm (2 in)
3760mm (148 in)
50mm (2 in)
A Lathe 115mm (4½ in)
B Oxy-acetylene rack
C Spark plug cleaner and tester
D Benches with cupboards and drawers
E Bench drilling machine
F Battery-charging plant
G Bench grinding and polishing machine
H Valve re-facing machine

The workshop body is fully enclosed and insulated. There is a rear door, four windows, roof lamps (230 V 60 W), flexible bench lights and electric extractor fans. The exterior is proofed for use in the tropics. There are two hardwood benches, racks, a tool cabinet, a cable drum and fire extinguisher, also a selection of machine tools which include a 2½ in lathe, a ⅝ in bench drill, two 6-in grinders and polishers, a machine for spark plug cleansing and testing, valve refacing equipment, a battery charger and a tyre inflater. Power supply is from a suitable generator-trailer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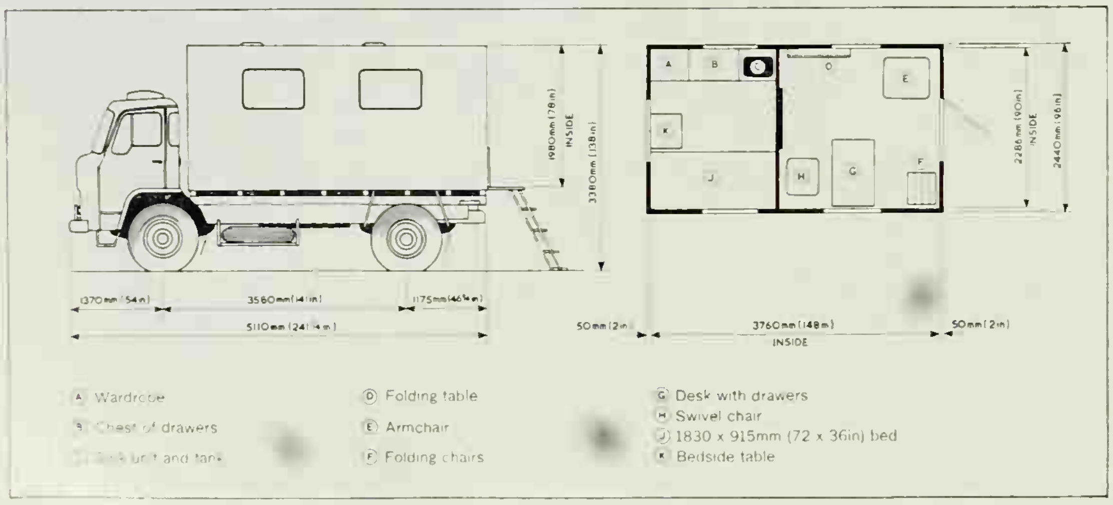
1175mm (46¼ in)
5110mm (241¼ in)
50mm (2 in)
3760mm (148 in)
50mm (2 in)
A Stowage cupboard
B Sink unit and water tank
C Attendant's tip-up seat
D Convertible stretcher/seat units, 4 stretcher case or 8 sitting case patients
E Tip-up seats for 5 sitting patients

The fully enclosed body of the ambulance version is divided into two compartments. The forward one is suitable for sitting cases and for carrying equipment; the rear compartment can either be arranged for four stretcher cases or eight seats. Two large double-doors extending the whole width of the body are fitted at the rear for ease of access. There are four sliding windows inside the truck and facilities for heating and ventilating. First-aid equipment is also supplied with this vehicle

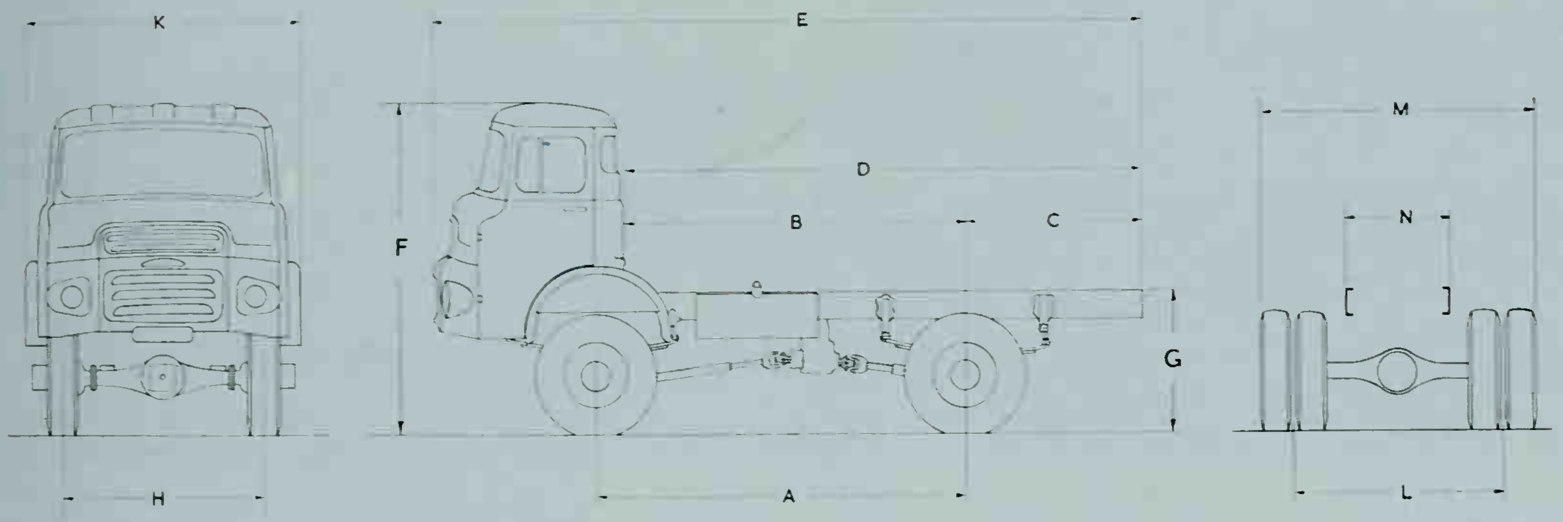

1980mm (78 in)
INSIDE
3380mm (133 in)
2286mm (90 in)
INSIDE
2440mm (96 in)
1370mm (54 in)
3560mm (141 in)
1175mm (46¼ in)
5110mm (241¼ in)
50mm (2 in)
3760mm (148 in)
INSIDE
50mm (2 in)
A Wardrobe
B Chest of drawers
C Sink unit and tank
D Folding table
E Armchair
F Folding chairs
G Desk with drawers
H Swivel chair
J 1830 x 915mm (72 x 36in) bed
K Bedside table

The basic construction of this caravan is similar to the workshop truck, but an additional window is fitted at the front of the body and a partition with sliding door is constructed approximately 282 cm (9 ft 3 in) from the rear. The front compartment is equipped as a bed and dressing room; the rear compartment is for use as an office. There are four other 4½/5 ton trucks available in this range designed for specific requirements: a message centre and exchange truck, a teleprinter truck, a charging signals truck and a telecommunications repair truck

Albion

4½/5-ton general service 4 x 4 cargo truck

The vehicle is suitable for all military applications where a 4½-ton payload is required cross-country. It is available in three alternative wheel bases (3089 mm, 3623 mm, 4080 mm), making it suitable for a wide range of applications. It is powered by a Leyland 0·370 diesel engine, developing 106 bhp at 2200 rev/min. The main gearbox has five forward gears and one reverse. An auxiliary box is fitted which, in addition to providing four-wheel drive when required, enables an extra-low ratio to be engaged, giving a further reduction of 2·04:1. Power-assisted steering is fitted as standard. The Albion can be fitted with a variety of bodies for military applications, including an engineering workshop, a portable stores system, a caravan and an ambulance.



Dimensions		mm	in			mm	in
A	Wheelbase	4080	160⅝	G	Height to top of chassis	1170	46
B	Rear of cab to rear axle	3850	151½	H	Track, front	1727	68
C	Rear overhang	1945	76½	K	Overall body width	2273	89½
D	Rear of cab to tail cf chassis	5790	228	L	Track, rear (centres of twin wheels)	1740	68½
E	Overall length	7380	290½	M	Width of rear axle	2280	89⅝
F	Overall height	2820	111	N	Width across chassis main members	865	34

Specification

Engine
Type: Leyland 370 diesel
Displacement: 6075 cm^3 (371 in^3)
Gross bhp: 106 at 2200 rev/min
Gross torque: 38·7 kgf m (280 lbf ft) at 1400 rev/min
Governed speed: 2200 rev/min
Ignition type: compression

Fuel system
Type: mechnical lift pump
Type of fuel: diesel
Air cleaner: oil bath
Fuel capacity: 113 litres (25 gal)

Transmission
Clutch: single dry plate 356 mm (14 in) dia
Gearbox: five forward speeds and one reverse (option of 6th forward speed)
Transfer box: two-speed
Transfer box ratios: 2·04:1 and 1·00:1
Axle type (front and rear): single-speed double-reduction (spiral bevel centre, epicyclic hubs)
Axle ratio: option of 5·555:1 or 6·250:1 or 6·933:1
Differentials: two

Electrical system
Voltage: 24 V
Wiring: insulated return available
Type of generator: alternator
Capacity of batteries: two 12 V 81 Ah capacity
Water-proofing, tropicalisation and suppression available

Steering
Type: Burman re-circulatory ball type, hydraulically assisted
Turning circle: 17·1 m (56 ft) or 20·4 m (67 ft) or 22·9 m 75 ft) depending on wheelbase

Wheels
Rims: B6·5 × 20 with 142 mm (5·6 in) offset
Tyres: 9·00 × 20–12 ply, singles front and twins rear
Options: 11·00 × 20–14 ply, single tyre equipment all round. This reduces the gross vehicle weight limit to 9297 kg (20 496 lb) on road and 8789 kg (19 376 lb) cross-country

Brakes
Hand: mechanical, power-assisted
Foot: air-over-hydraulic, all wheels
Warning devices: buzzer and gauge

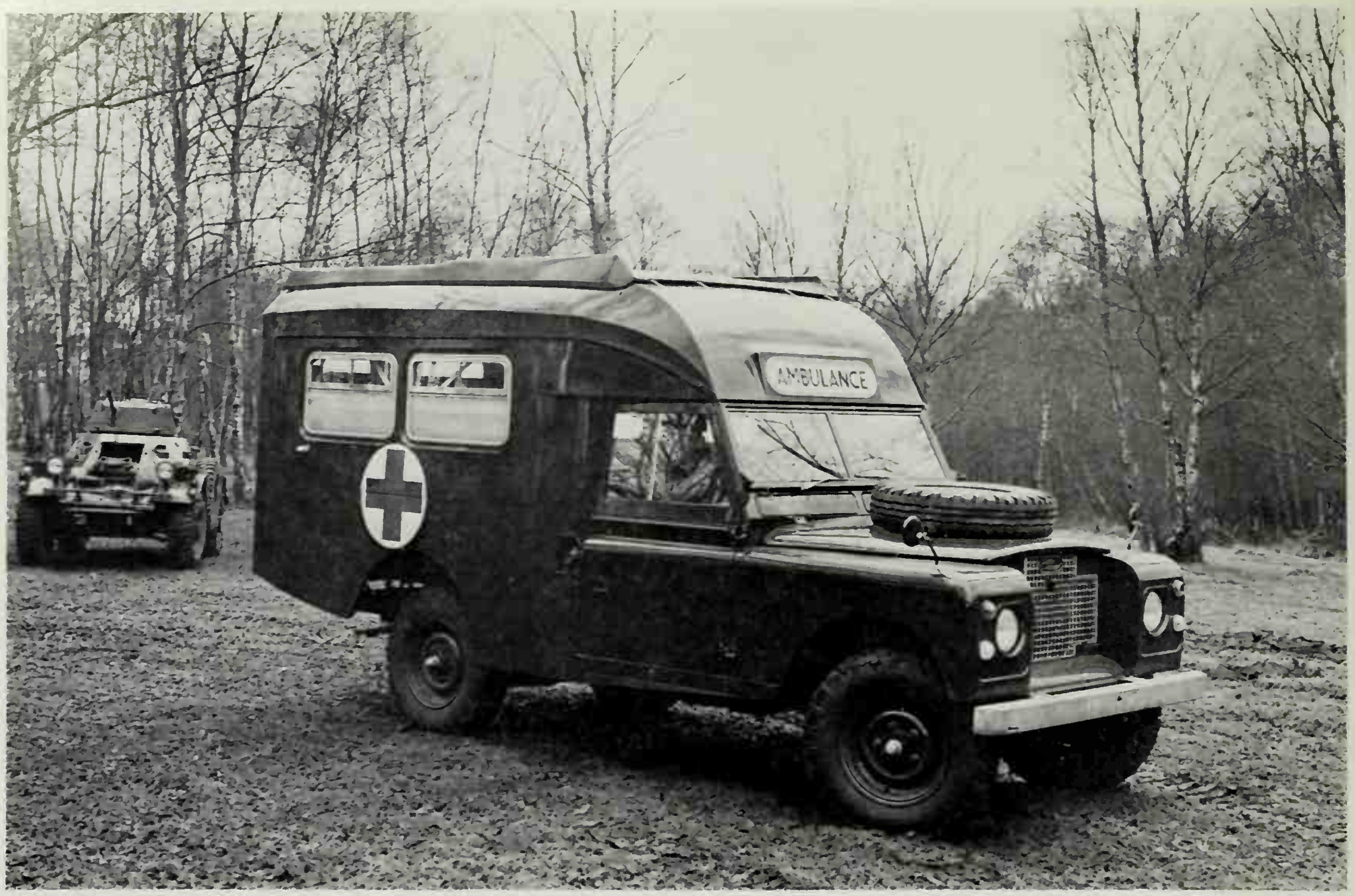
Suspension
Type—front: semi-elliptic leaf springs
rear: semi-elliptic leaf springs
Shock absorbers: hydraulic, telescopic, at front axle

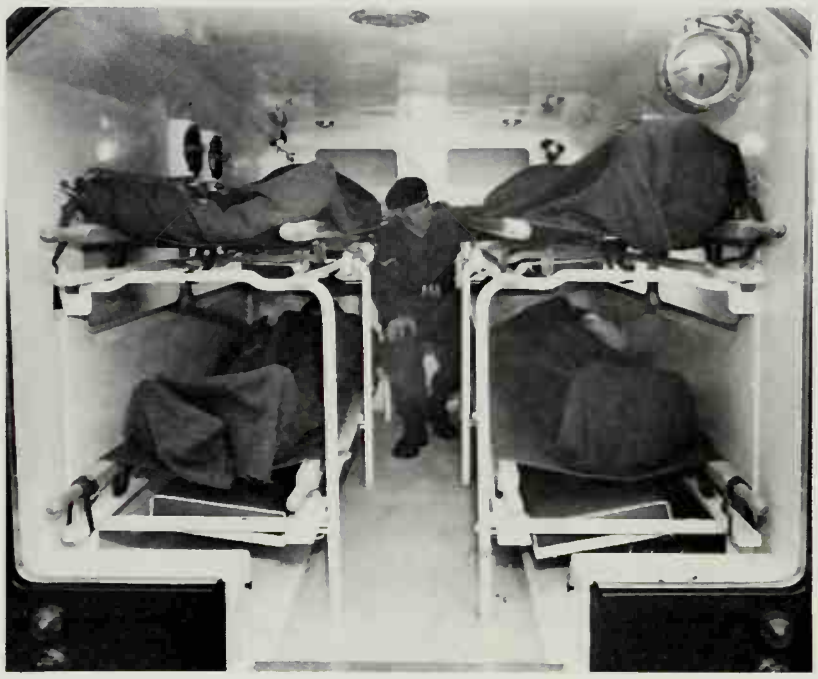
Performance data
Unladen weight: 4217 kg (9296 lb)
Gross weight: 12 193 kg (26 880 lb) on road, 10 161 kg (22 400 lb) cross-country
Speed, average maximum: 72 km/h (45 mph) with 6·250:1 axle ratio
Range of action at average maximum speed: 400–480 km (250–300 miles)
Gross power weight ratio (bhp per ton): 9·7
Maximum tractive effort, in low gear: 485 kg (1071 lb) per ton with 6·250:1 axle ratio
Maximum climbing ability: 1 in 2 with 6·250:1 axle ratio
Maximum gradient for stop and restart: 1 in 3 with 6·250:1 axle ratio

Military characteristics
Roles: cargo, office, workshop, engineering plant, caravan and ambulance (appropriate bodies available)
Cargo area: dependent on types of body
Towing ability: rear hook available

ALBION MOTORS LIMITED
Military Sales Division
Berkeley Square House, Berkeley Square, London W1, England
Telephone: 01-499 6050 Cables: Leymotors London W1 Telex Telex: 22498

BRITISH
LEYLAND





The four-stretcher ambulance on the 277 cm (109 in) wheelbase Land Rover chassis has been specially developed by Pilcher for military purposes and for use in civil disasters. The rear compartment of the ambulance provides accommodation for four full-length military stretchers, or two stretchers and four sitting patients, or eight sitting patients. In all combinations of accommodation, a fold-up seat is provided for one attendant.

Military ambulance

Four-stretcher body on long-wheelbase Land Rover

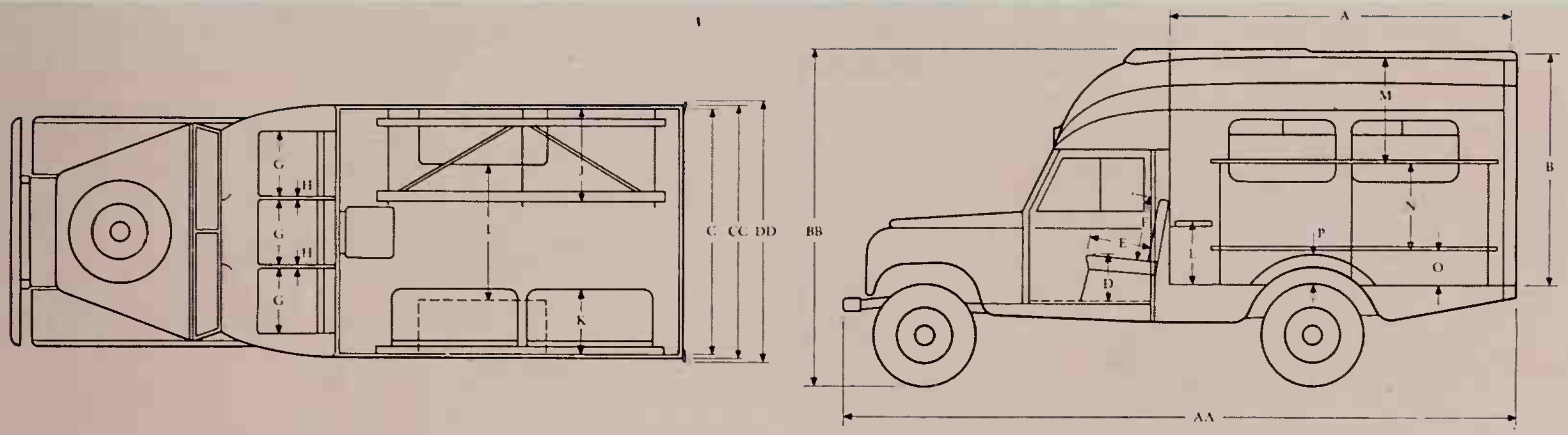
This vehicle is a great step forward in the development of a 4 × 4 ambulance for military and civil disaster use.

The most advanced methods are used in the construction of the body, which is of the one-piece double-skin type, fully moulded in glass-reinforced plastics. The advanced specifications include injection insulation, colour impregnation and fire-retardation.

The floor is also moulded of glass-reinforced plastics with integral tread pattern; it is therefore not necessary to use any type of floor covering. The floor is further reinforced between the skin mouldings with 19 mm (¾ in) plywood. The interior walls are of colour-impregnated plastics and can be easily cleaned; the seats are also of an easy-clean material. The roof is of the same construction as the remainder of the body, that is double-skin glass-reinforced plastics with injection insulation, giving a very high degree of thermal insulation and good shock-absorbing properties. An additional tropical roof can also be supplied.

One of the advantages of this ambulance is that the Pilchers bodywork is colour-impregnated and never requires repainting, repair kits being available in a matching colour. The interior is also colour-impregnated.

The Pilcher four-stretcher ambulance has the same roadability and cross-country capability as the original 277 cm (109 in) wheelbase Land Rover, which is fully described elsewhere in this Catalogue, complete with technical specification. Brief specifications of the Pilcher ambulance body are given below.



		Metres	Inches			Metres	Inches
	Wheelbase	2·768	(109)	**F**	Front squab height	0·431	(17)
	Track	1·308	(51½)	**G**	Width of front cushions	0·457	(18)
AA	Overall length	4·800	(189)	**H**	Width between front seats	0·025	(1)
BB	Overall height	2·413	(95)	**I**	Width between wheel boxes	0·977	(38½)
CC	Overall width	1·790	(70½)	**J**	Width of stretcher rack	0·660	(26)
DD	Overall width over hinges	1·892	(74½)	**K**	Width of seat	0·457	(18)
A	Interior length	2·336	(92)	**L**	Height of nurses seat	0·457	(18)
B	Interior height	1·524	(60)	**M**	Height between top rack and roof	0·622	(24½)
C	Interior width	1·701	(67)	**N**	Height between top and bottom rack	0·622	(24½)
D	Top of front cushion to floor	0·368	(14½)	**O**	Height of bottom rack	0·406	(16)
E	Front to rear of front cushion	0·406	(16)	**P**	Height of wheel boxes	0·228	(9)

Specification

Power unit
The following power units are available:
4-cylinder 2¼ litre petrol engine
6-cylinder 2·6 litre petrol engine
4-cylinder 2¼ litre diesel engine

Bodywork
Constructed of a one-piece, double-skin, fully moulded glass-reinforced plastics

Insulation
Complete body insulated with injection Fibreglass insulation

Rear doors
Double full-width rear doors made to open and secure flat to body side. Two-way locking bar with interior handle secures left-hand door. Right-hand door secured by double-locking handle. Interior head pad above door opening

Lighting
Two windows with opening section in each side of body. Plain, frosted, or darkened safety glass. One fixed window in each rear door. 12 V interior lighting system

Rear steps
Folding rear step with locking bar

Ventilation
Two adjustable air intakes and one large-capacity extractor. Two 12 V rubber-bladed fans

Windscreen
Basic Rover fixed screen

Driver's bulkhead
Full-length with central opening complete with roll-up blinds. Two open lockers

Driver's compartment
Rover windscreen, cab doors, sidescreens and cab seats

Finish
Interior: white or ivory colour-impregnated plastics laminate
Exterior: colour-impregnated in colour selected, with some lettering

Standard fittings
Illuminated ambulance sign, siren or alarm bell, twin wipers and wing mirrors

Interior
Two Pilchers folding stretcher racks with fold-up seats.
Accommodation: four stretchers, or two stretchers and four seats or sitting cases, or eight seats for sitting cases, plus attendant's seat

Optional extras
Blood bottle holder, vacuum flask, forced ventilation system, 178 mm (7 in) dia rear floodlamps, tropical roof, fluorescent interior lamps, telescopic or Mk 2 stretchers, ventilated floor compartment, first-aid kit, flashing roof beacon, reversing lamp, universal spotlight on screen pillar, heater, resuscitation equipment, provision for two-way radio, air conditioning, fire extinguisher

Weight
1930 kg (4256 lb)

PILCHERS (MERTON) LIMITED
Victoria Road, Burgess Hill, Sussex, England
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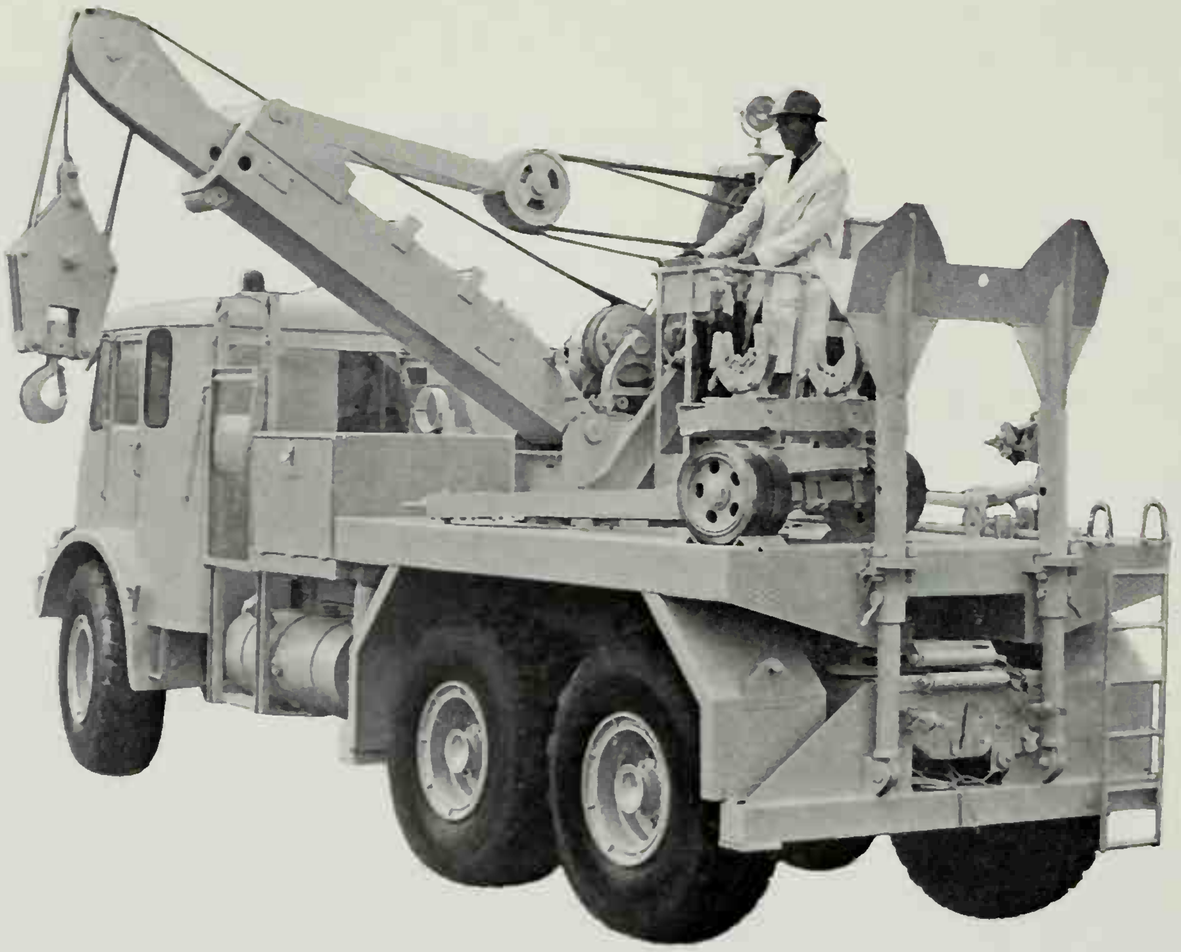
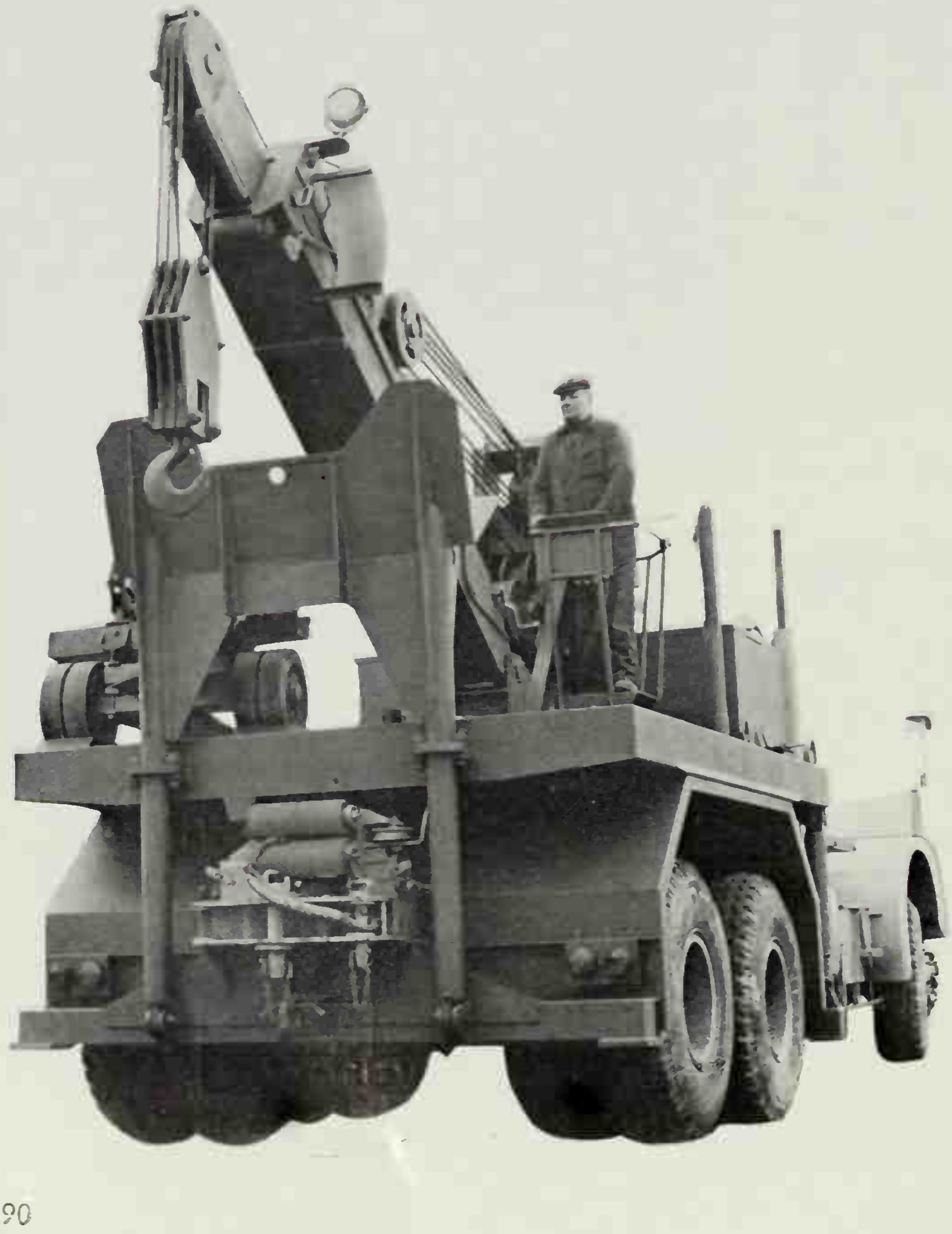
AEC Militant 10-ton recovery crane



Scammell Constructor 12-ton recovery crane



Additional equipment

1 Salvage winch (mechanical or hydraulic)
2 Snatch blocks—single sheave with swivel oval eye, working load 10 tons
12 Shackles, 5-ton capacity
8 Ground anchors
1 'A' type distance frame
2 Floodlight equipment—one illuminating deck and crane, one swivelling to illuminate work
1 Spade, shovel, axe, crowbar, sledgehammer
2 Wire bonds 5·48m (18ft) long, 19mm (¾in) dia wire eyes each end

Double lashing chains

(a) 1 off comprising 2 legs 1·8m (6ft) long, 1 ring and 2 hooks, leg capacity 5 tons each
(b) 2 off comprising 2 legs 1·8m (6ft) long, 1 ring and 2 hooks, leg capacity 2½ tons each
(c) 1 off comprising 4 legs 1·8m (6ft) long, 1 ring and 4 hooks, leg capacity 2½ tons each
2 Hydraulic bottle jacks, 8-ton capacity
1 Rear spade designed to support jib under suspended-tow conditions, providing greater safety under vertical lifts
2 Timber packing, hardwood 152cm × 20cm × 10cm (5ft × 8in × 4in)
2 Timber jack blocks, hardwood 30cm (1ft) cube
4 Timber supports for jack leg feet, hardwood 30cm × 30cm × 10cm (1ft × 1ft × 4in)
1 Heavy duty towpole
1 5-ton breakdown ambulance
1 Flashing beacon on cab roof

Heavy recovery vehicles

10-ton and 12-ton capacity

The body is all electrically welded with 20·3cm (8in) pressed steel channel crossmembers mounted on rolled steel channel mainbearers adequately gussetted at all intersections. Floor in 6·35mm (¼in) mild steel Chequer plate pressed to form capping to extremities of cross members, stitch-welded to underframe. Outrigger jack support beams fabricated in box sections mounted below chassis members, the forward beam braced up to body and incorporating sliding inner portion extending 45·7cm (1ft 6in) each side. Access steps fitted at rear. Underframe strengthened to receive crane slewing ring.

The toolbox is in 10swg steel sheet extending for the full width of body 61cm high × 121cm wide (2ft × 4ft) fitted with hinged access flaps at the rear of the cab.

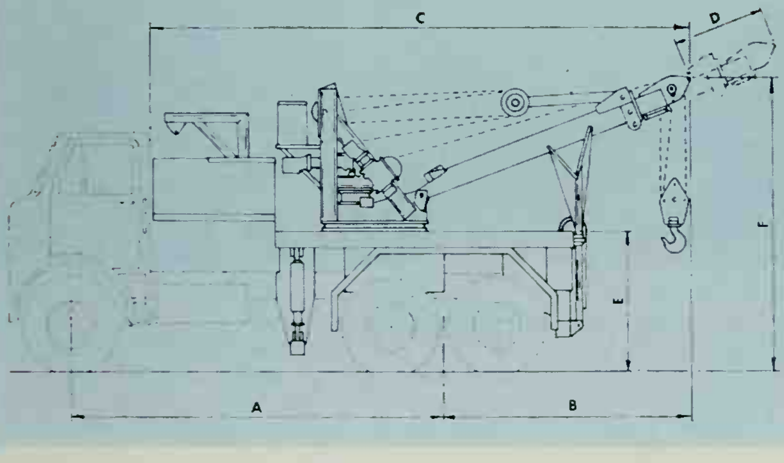
Crane hoisting, slewing and luffing are hydraulically operated; jib extension is by hand. The Boughton V19H hoisting winch is worm-driven with automatic brake incorporating sheave headpiece and sheave crane block with swivel hook giving approximately 2·43m (8ft) per min hook speed, with rope falls of 15·8mm (⅝in) dia 6/37specially improved plough wire rope. The V19H unit is also used for luffing.

Recovery crane mounted on ball bearing slewing ring hydraulically operated from common power source via appropriate valve, having 180deg slewing, speed approximately 2–2½rev/min with full load.

Jib extension manually operated by winch mounted below main jib fitted with 6.35mm (¼in) dia 6/19 specially improved plough wire rope, giving 121cm (4ft) extension. Locking pin provided to sustain jib at 40·6cm (16in) intervals.

Hydraulic power generated by a suitable pump driven from a single-speed power take-off which should be supplied with the chassis.

Load indicator fitted to main jib suitably marked showing safe loads.



APPROXIMATE DIMENSIONS

Model	A	B	C	D	E	F	Width
*AEC cm	483	244	732	122	165	331	244
0870 in	190	96	288	48	65	130	96
†Scammell cm	510	335	670	122	170	360	290
Constructor in	200	132	264	48	67	142	114
Foden cm	371	244	544	122	157	325	244
in	146	96	214	48	62	128	96

*17 tons fully laden †21 tons fully laden

SAFE WORKING LOADS FOR AEC MILITANT

Jib positioned at the rear	Load luffed at 20°		Load luffed at 45°	
	Jacked	Free	Jacked	Free
Min length kg	10 160	8618	—	—
lb	22 400	19 000	—	—
1st extension kg	6100	6100	6100	6100
lb	13 440	13 440	13 440	13 440
2nd extension kg	4064	4064	4064	4064
lb	8960	8960	8960	8960
Full extension kg	3048	3048	3048	3048
lb	6720	6720	6720	6720

Jib positioned at 90°	Load luffed at 20°		Load luffed at 45°	
	Jacked	Free	Jacked	Free
Min length kg	6852	3311	8365	3556
lb	15 150	7300	18 480	7840
1st extension kg	5080	3070	6100	3311
lb	11 200	6770	13 440	7300
2nd extension kg	4064	2789	4064	3048
lb	8960	6150	8960	6720
Full extension kg	3048	2181	3048	2540
lb	6720	4810	6720	5600

SAFE WORKING LOAD FOR SCAMMELL CONSTRUCTOR

Jib positioned at the rear	Load luffed at 20°		Load luffed at 45°	
	Jacked	Free	Jacked	Free
Min length kg	12 240	8708	12 240	10 523
lb	26 988	19 200	26 988	23 200
1st extension kg	7348	7348	7348	7348
lb	16 200	16 200	16 200	16 200
2nd extension kg	4828	4828	4828	4828
lb	10 640	10 640	10 640	10 640
Full extension kg	3556	3556	3556	3556
lb	7840	7840	7840	7840

Jib positioned at 90°	Load luffed at 20°		Load luffed at 45°	
	Jacked	Free	Jacked	Free
Min length kg	6532	1814	11 612	3084
lb	14 400	4000	25 600	6800
1st extension kg	5987	1451	9434	2902
lb	13 200	3200	20 800	6400
2nd extension kg	4717	1451	7983	2540
lb	10 400	3200	17 600	5600
Full extension kg	3991	1088	7983	2177
lb	8800	2400	17 600	4800

REYNOLDS BOUGHTON LIMITED

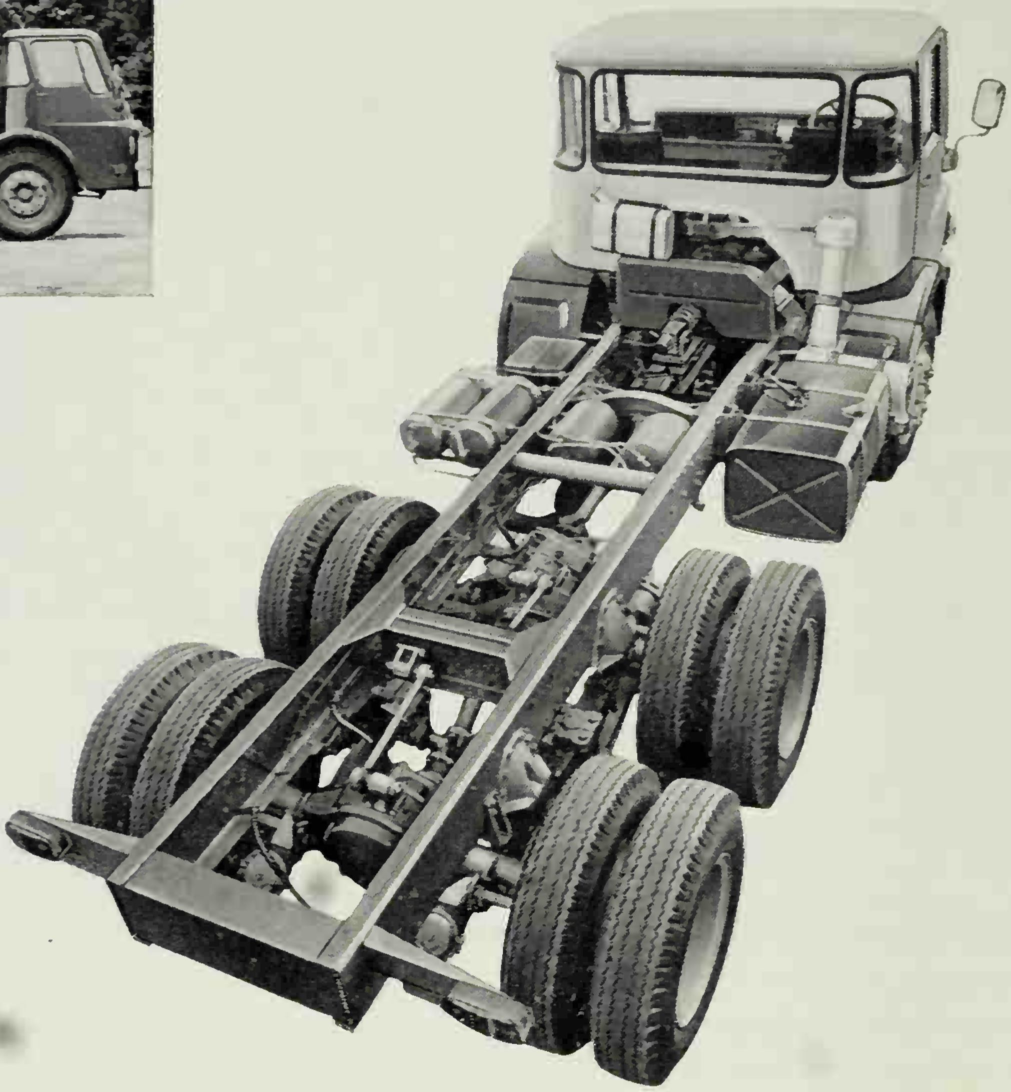
Vehicle Division

Bell Lane, Amersham, Buckinghamshire, England

Telephone: Little Chalfont 2666 Cables: Boughtons Amersham Telex: 83132

This Dodge heavy-duty vehicle is available with a wide choice of cargo bodies, tipper variants being illustrated. Different wheelbase lengths add additional versatility to this popular model

Illustrated at the right is the basic standard chassis form; clearly shown is the bolted chassis structure, a construction which enables easier realignment of chassis members should any distortion occur under excess load conditions



Dodge

14-ton heavy-duty truck

The Dodge 14-ton heavy-duty truck is a wheeled, robust long-distance vehicle with rigid chassis, powered to maintain high convoy speeds. Experience in many areas has shown it to be fully dependable even under the most adverse conditions of operation.

The five-speed gearbox with full synchromesh on the top four gears, careful layout of all controls, spacious cab and other features reduce driver fatigue to a minimum. The twin wheels on the two rear axles make for sure-footed progress even on slippery surfaces.

The basic truck is available in a wide range of wheelbases. This, combined with the bolted construction of the chassis, facilitates conversion from the basic load-carrying model to heavy-duty tipper or specialised vehicle transporter.

Specification

Engine type: Perkins diesel V8·510
Gross bhp: 185 at 2800rev/min
Nett torque: 51kg m (378lb ft) at 1600rev/min
Lubrication: wet sump with full-flow oil filter
Fuel tank capacity: 227 litres (50gal)

Transmission
Clutch: single dry plate 381mm (15in) dia
Gearbox: five forward, one reverse, 2nd, 3rd, 4th, 5th synchromesh engagement
Propeller shafts: needle roller bearing
Drive axle: two-speed Eaton 38DT fully floating, spiral bevel. Third differential with air-operated lock. Ratio 7·17/9·77:1

Brakes
Foot: full air dual circuit. Lining area 8200cm^2 (1272in^2)
Hand: full air with positive mechanical lock on front and front driving axles

Tyres: 10·00 × 20-16 ply rating

Steering
Type: recirculating ball, variable ratio
Turning circle: 18·28m (60ft)

Suspension
Front: semi-elliptic leaf springs
Rear: semi-elliptic leaf spring with equalising beams

Electrical equipment: 24V negative earth return with 720W alternator

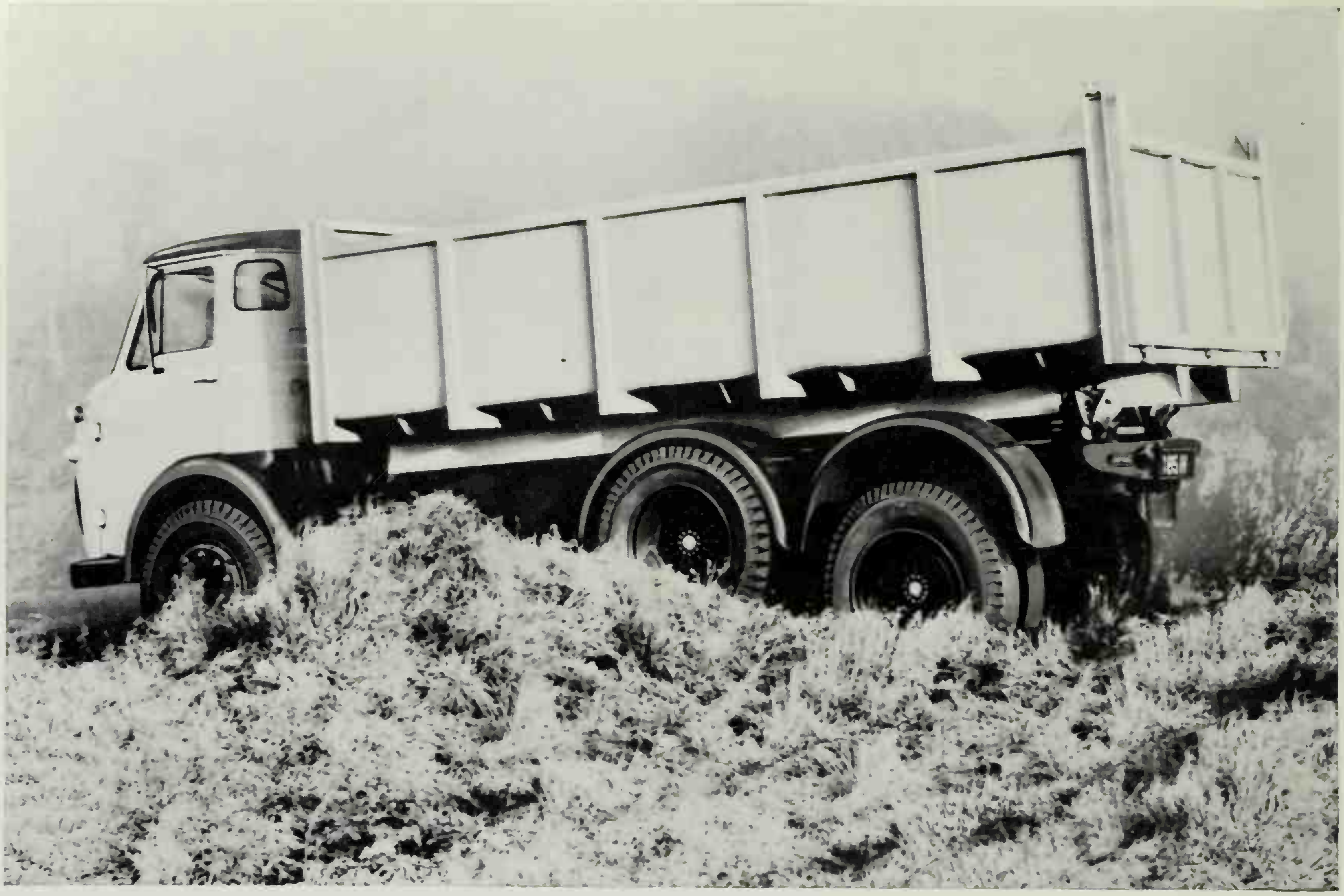
Weights
Unladen—chassis/cab with fuel, oil, water and spare wheel: 6360kg (14 020lb)
Gross vehicle weight: 22 352kg (49 280lb)

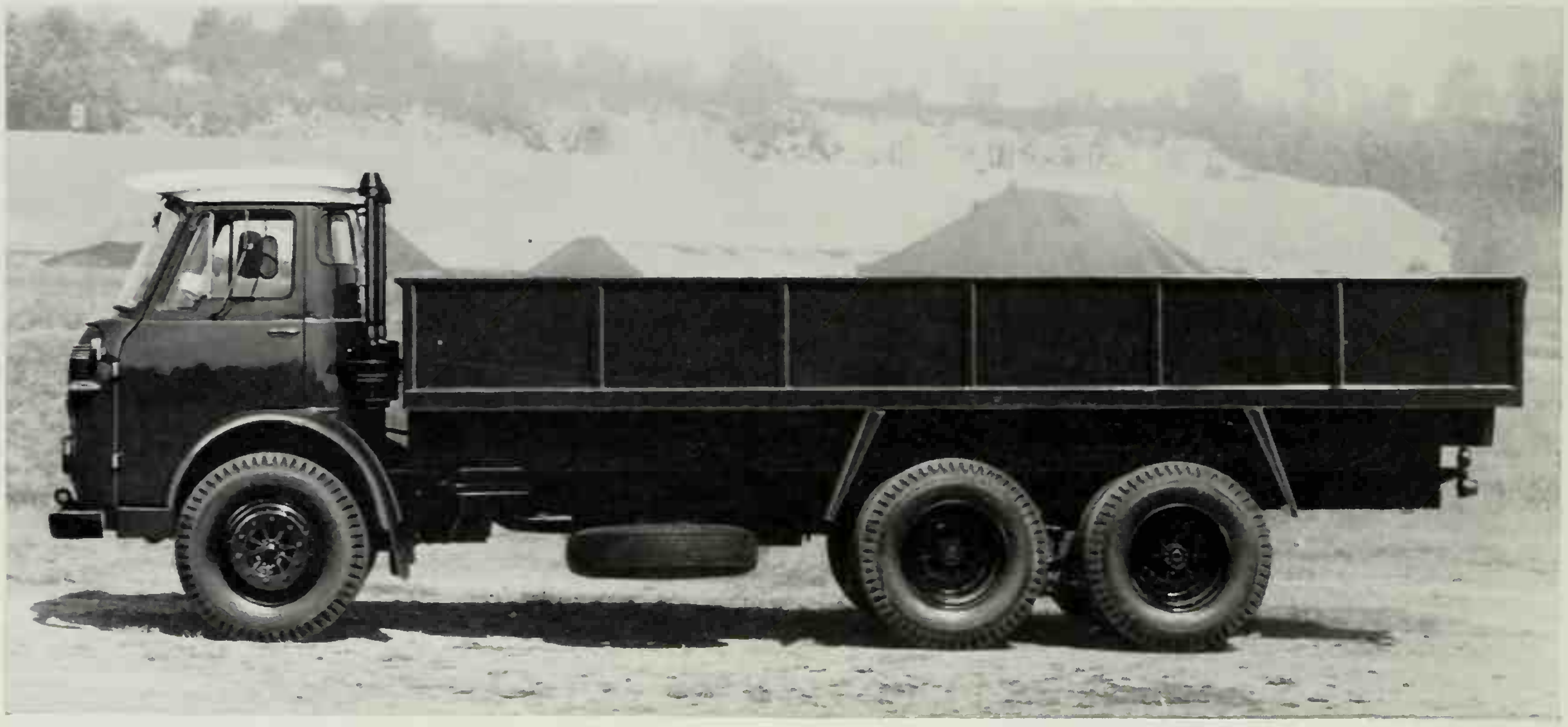
Dimensions
Overall length: 9·220m (363in)
Overall width: 2·394m (94¼in)
Overall height: 2·438m (96in)
Wheelbase: 5·080m (200in)
Track, front: 2·032m (80in)
rear: 1·809m (71¼in)
Ground clearance (laden): 234mm (9·6in)

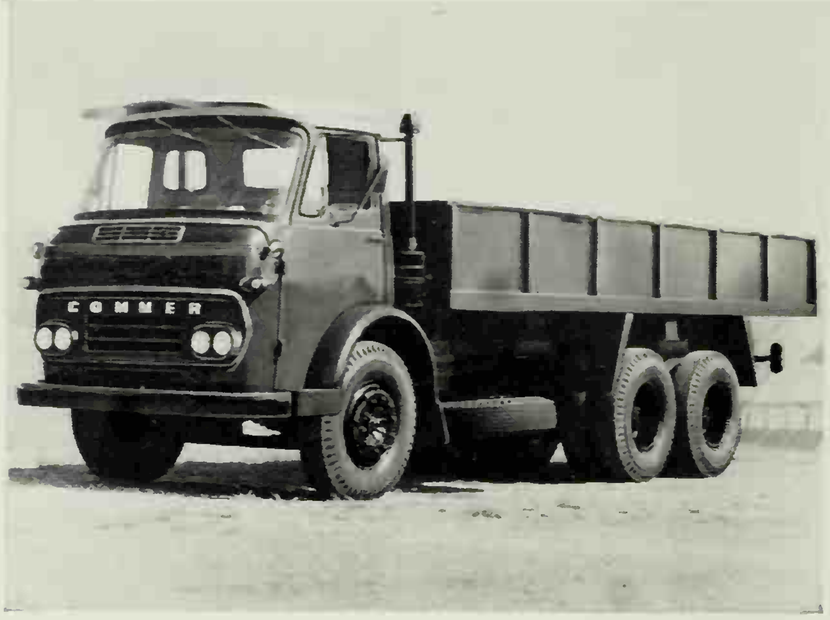
Performance
Max. speed: 74km/h (46mph)
Range (road use): 644km (400 miles)
Tractive effort—1st gear: 6350kg (14 000lb)
Max. gradient climbable based on rolling resistance of 13·4kg/1000kg (30lb/2240lb): 27%

ROOTES MOTORS LIMITED
Export Sales Division
26-40 Kensington High Street, London W8, England
Telephone: 01-937 8077 Cables: Rootesmoti London W8 Telex: 23535

ROOTES







Illustrated here in typical military setting, the Commer 10-ton heavy-duty rigid-chassis truck is shown travelling over rough ground. Also illustrated is the vehicle stationary in a firing range and at a field unit, having delivered ammunition and engineering stores

Commer

10-ton heavy-duty truck

With its proven record as a heavy-duty load-carrying vehicle, this Commer 10-ton wheeled rigid-chassis truck is ideal for transporting heavy loads such as bridging equipment, field defence stores, mines and ammunition.

Its strong carbon-manganese steel chassis combines with its superb suspension to smooth the ride over the rougher terrain.

On the open road, it has the power to match convoy speeds under full load and in all weather. The diesel engine of proven design, acting on two twin-tyred rear axles fitted with equalising beams, give the vehicle excellent performance in difficult terrain.

The careful layout of the cab, combined with power-assistance on the steering, ensures that driver fatigue is kept to the minimum even on long runs at full load over difficult terrain. Equipment is designed to give long life under typical service conditions.

The body type illustrated here is only one of several available. The wheelbase quoted in the specification below is the most popular, but trucks with longer or shorter wheelbases, to suit different types of bodies and tasks, are also available.

Specification

Engine type: Roots 3D.215
Gross bhp: 125 at 2400rev/min
Nett torque: 43·95kg m (318lb ft) at 1300rev/min
Lubrication: wet sump with full-flow oil filter
Fuel tank capacity: 190 litres (42gal)

Transmission
Clutch: single dry plate 355mm (14in) dia
Gearbox: five forward, one reverse. 2nd, 3rd, 4th, 5th synchromesh engagement
Propeller shafts: needle roller bearing
Drive axle: single-speed Eaton 30DT fully floating spiral bevel. Third differential with air-operated lock. Ratio 7·17:1

Brakes
Foot: air/hydraulic divided line. Lining area 6800cm^2 (1054in^2)
Hand: air-assisted to rear bogie

Tyres: 9·00 × 20–14 ply rating

Steering
Type: cam and peg, power-assisted
Turning circle: 21·3m (70ft)

Suspension
Front: semi-elliptic leaf spring with lever-type hydraulic shock absorbers
Rear: semi-elliptic leaf spring with equalising beams

Electrical equipment: 12V negative earth return with 420W alternator

Weights
Unladen—chassis/cab with fuel, oil, water and spare wheel: 4284kg (11 650lb)
Gross vehicle weight: 18 285kg (40 300lb)

Dimensions
Overall length: 8·915m (351in)
Overall width: 2·263m (89⅛in)
Overall height: 2·534m (99¾in)
Wheelbase: 4·863m (191½in)
Track, front: 1·806m (71⅛in)
rear: 1·702m (67in)
Ground clearance (laden): 226mm (8·9in)

Performance
Max. speed: 61km/h (38mph)
Range (road use): 676km (420 miles)
Tractive effort: 1st gear: 3982kg (8780lb)
Max. gradient climable based on rolling resistance of 13·4kg/1000kg (30lb/2240lb): 20·8%

ROOTES MOTORS LIMITED
Export Sales Division
26-40 Kensington High Street, London W8, England
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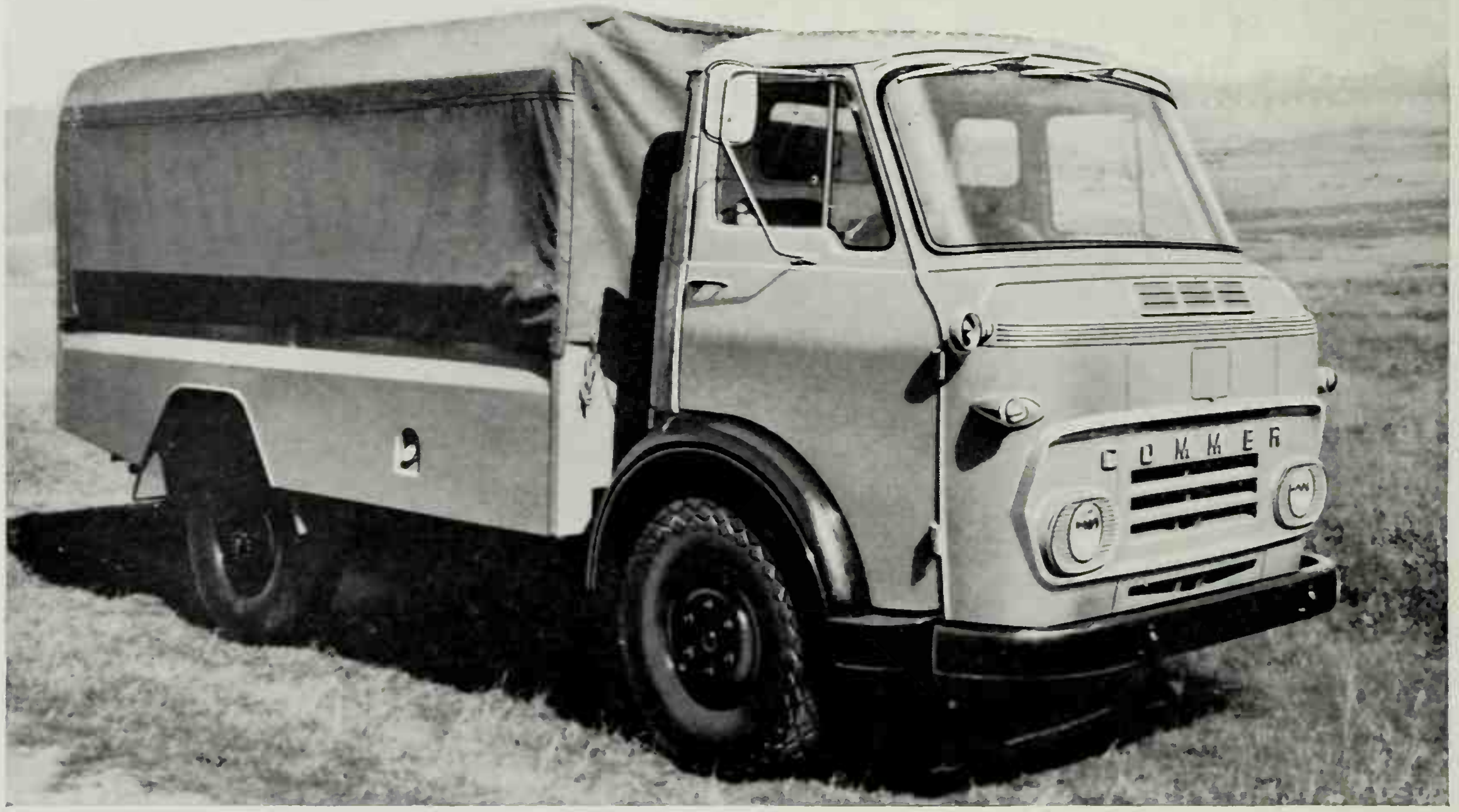
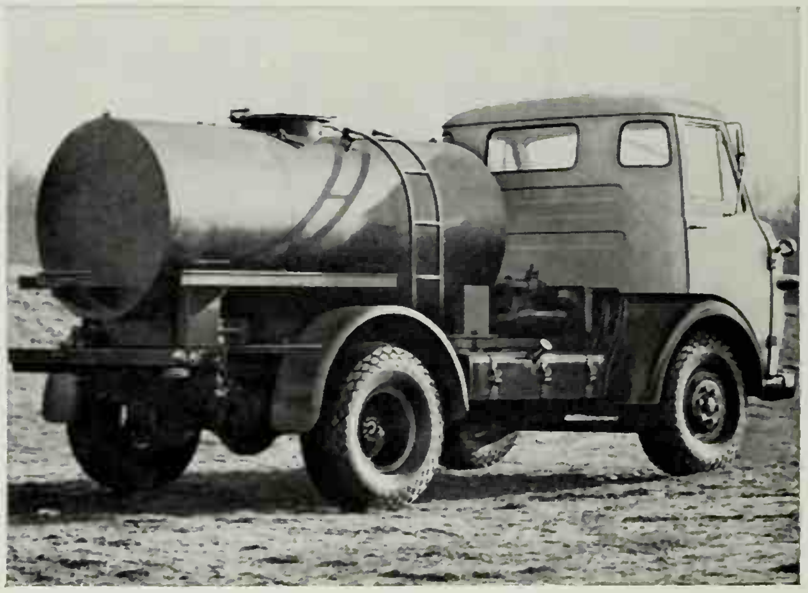
ROOTES





The Commer 2-ton heavy-duty pick-up is the ideal general-purpose personnel carrier; illustrated with soft-ground tyres, it provides convenient transport to and from the firing range and yet is tough and dependable enough for use in more arduous conditions. As a bulk-liquid carrier, a further use for this most adaptable vehicle is illustrated; again soft-ground tyres add to its versatile characteristics

Commer

2-ton heavy-duty pick-up

Its extremely versatile rigid chassis makes this Commer 2-ton heavy-duty pick-up truck a great asset in any modern army.

Apart from its obvious uses as a load carrier, it can be adapted to fulfil a variety of requirements, including those of personnel and bulk-liquid transportation.

It is powered by a diesel engine of proven economy, with synchromesh transmission on top three gears and has a full tank capacity range that more than covers normal supply distances. Fitted with soft-ground tyres, it excels in the most arduous conditions.

Free access to all parts of the engine and chassis render maintenance in the field easy, while robust construction and careful design reduce the need for maintenance to a minimum.

The high road speed combined with good cross-country performance render this vehicle suitable for general duties with most types of fighting unit.

Specification

Type: Diesel
Engine: Perkins 4·236
Gross bhp: 80 at 2800rev/min
Nett torque: 25·9kg m (187lb ft) at 1500rev/min
Lubrication: wet sump with full-flow oil filter
Fuel tank capacity: 136 litres (30gal)

Transmission
Clutch: single dry plate 279mm (11in) dia
Gearbox: four forward, one reverse, 2nd, 3rd, 4th synchromesh engagement
Propeller shafts: needle roller bearing
Drive axle: fully floating, spiral bevel, ratio 5·43:1

Brakes
Foot: air/hydraulic divided line. Lining area 2580cm^2 (400in^2)
Hand: mechanical to rear wheels

Tyres: 10·50 × 16–12 ply, rating Sand

Steering
Type: cam and peg
Turning circle: 13·41m (44ft)

Suspension
Front: semi-elliptic leaf spring with lever-type hydraulic shock absorbers
Rear: semi-elliptic leaf spring with lever-type hydraulic shock absorbers

Electrical equipment: 12V negative earth return with 420W alternator

Weights
Unladen—chassis and cab with fuel, oil, water and spare wheel: 2735kg (6030lb)
Gross vehicle weight: 5440kg (12 000lb)

Dimensions
Overall length: 5·537m (218in)
Overall width: 2·200m (86⅝in)
Overall height: 2·464m (97in)
Wheelbase: 2·921m (115in)
Track, front: 1·829m (72in)
rear: 1·905m (75in)
Ground clearance (laden): 209mm (8¼in)

Performance
Max. speed: 84km/h (52mph)
Range (road use): 724km (450 miles)
Tractive effort—1st gear: 1767kg (3895lb)
Max. gradient climbable based on rolling resistance of 13·4kg/1000kg (30lb) 2240lb): 31%

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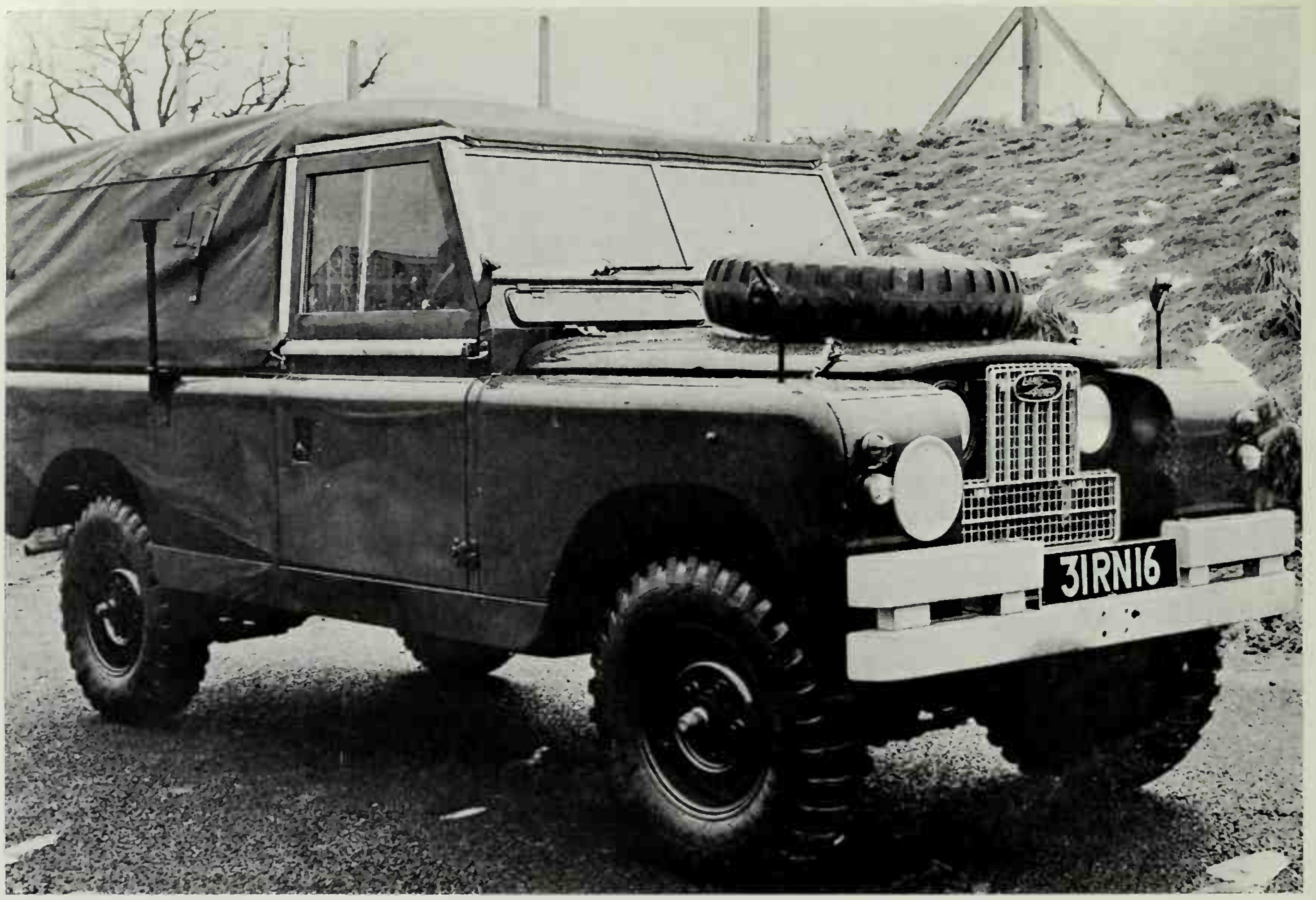
ROOTES



The long-wheelbase Land Rover (227cm, 109in) shown above can be adapted to many uses, some of which are shown below: **1** with Scottorn powered-axle trailer, **2** with 105mm Pack howitzer, **3** with Moy aircraft loader, **4** as four-stretcher ambulance, **5** with 120mm Wombat, **6** as fire tender, **7** fitted for radio (FFR), **8** as FFR command vehicle, and **9** with Wombat in action

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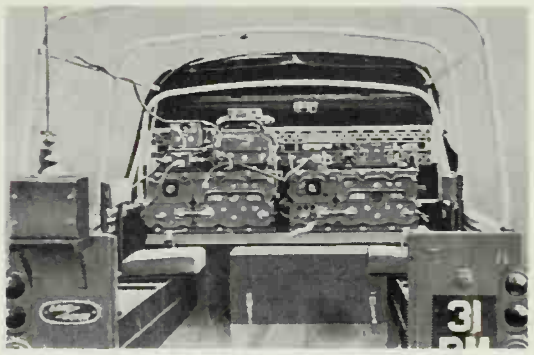

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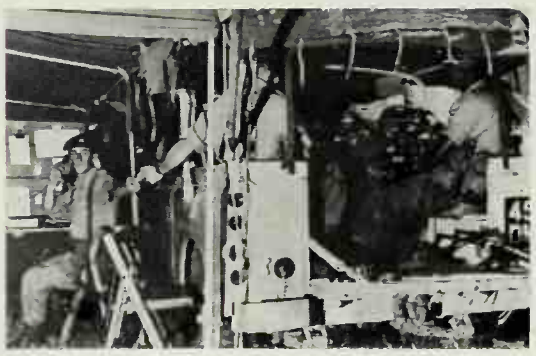


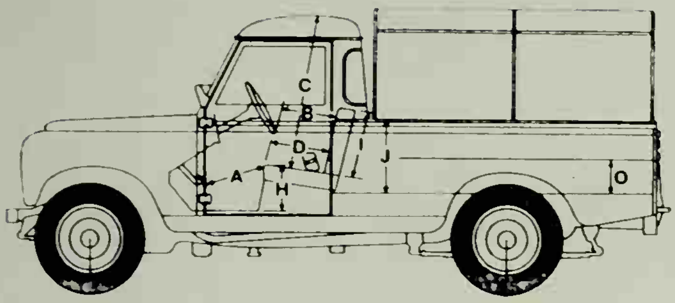
9

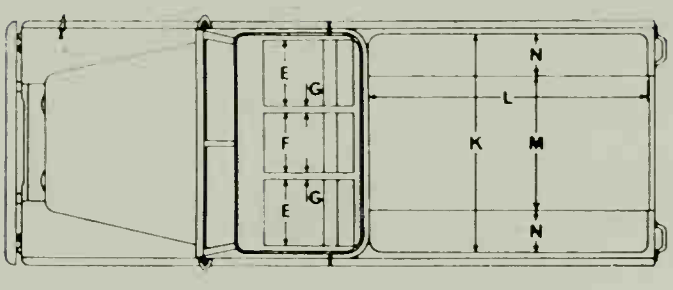
Land Rover

military ¾-ton model

This world-famous 277-cm (109-in) wheelbase vehicle is the standard vehicle in its load class in all British Services and many other armed forces throughout the world. The specification includes FV design towing hook, twin fuel tanks, vehicle lashing eyes at front and rear, freight lashing cleats in body, rear bumpers and front bumpers modified to permit pushing of one vehicle by another, oil cooler and eight-bladed fan, FV pattern lights, chassis frame with extended spring shackles to permit fitment of larger tyres when required, etc. The vehicle is available in both '12-voit cargo' and '24-volt fitted for radio' (FFR) specifications. The FFR version incorporates a 90A rectified ac electrical system with provision for charging wireless batteries, full suppression of electrical equipment, wireless table, battery carrier, two 100Ah batteries, co-axial leads, HF aerial brackets, operators seats, etc.

RAF
FIRE SERVICE





		Metres	Inches
	Wheelbase	2·768	109
	Track	1·308	51·5
	Overall length	4·441	175
	Overall width (over hinges)	1·676	66
	Overall height of cab	1·86	73·25
	Overall height with hood	1·905	75
A	Front cushion to accelerator pedal	0·438	17·25
B	Front squab to steering wheel	0·369	14·5
C	Headroom front seat (uncompressed)	0·991	39
D	Front to rear of front cushion	0·406	16
E	Width of front cushion	0·457	18

		Metres	Inches
F	Width of front centre cushion	0·381	15
G	Width between front seats	0·025	1
H	Top of front cushion to floor	0·368	14·50
I	Front squab height	0·431	17
J	Height of body sides	0·483	19
K	Width of body interior	1·444	56·87
L	Length of body interior	1·85	72·75
M	Interior body width between wheel boxes	0·921	36·25
N	Width of wheel boxes	0·349	13·75
O	Height of wheel boxes	0·229	9

Specification

General
Loading area: 1·43 × 1·83m (56¼ × 72in)
Ground clearance (laden): 0·24m (9in)
Turning circle: 14·3m (47ft)
Unladen weight: 1630kg (3710lb)
Gross vehicle weight (approx.): 2680kg (5905lb)

Engine
Type: 2·25 litre, four-cylinder petrol

Transmission
Main gearbox ratios:

Top	direct
Third	1·512:1
2nd	2·22:1
1st	3·6:1
Rev	3·0:1

Transfer box ratios:

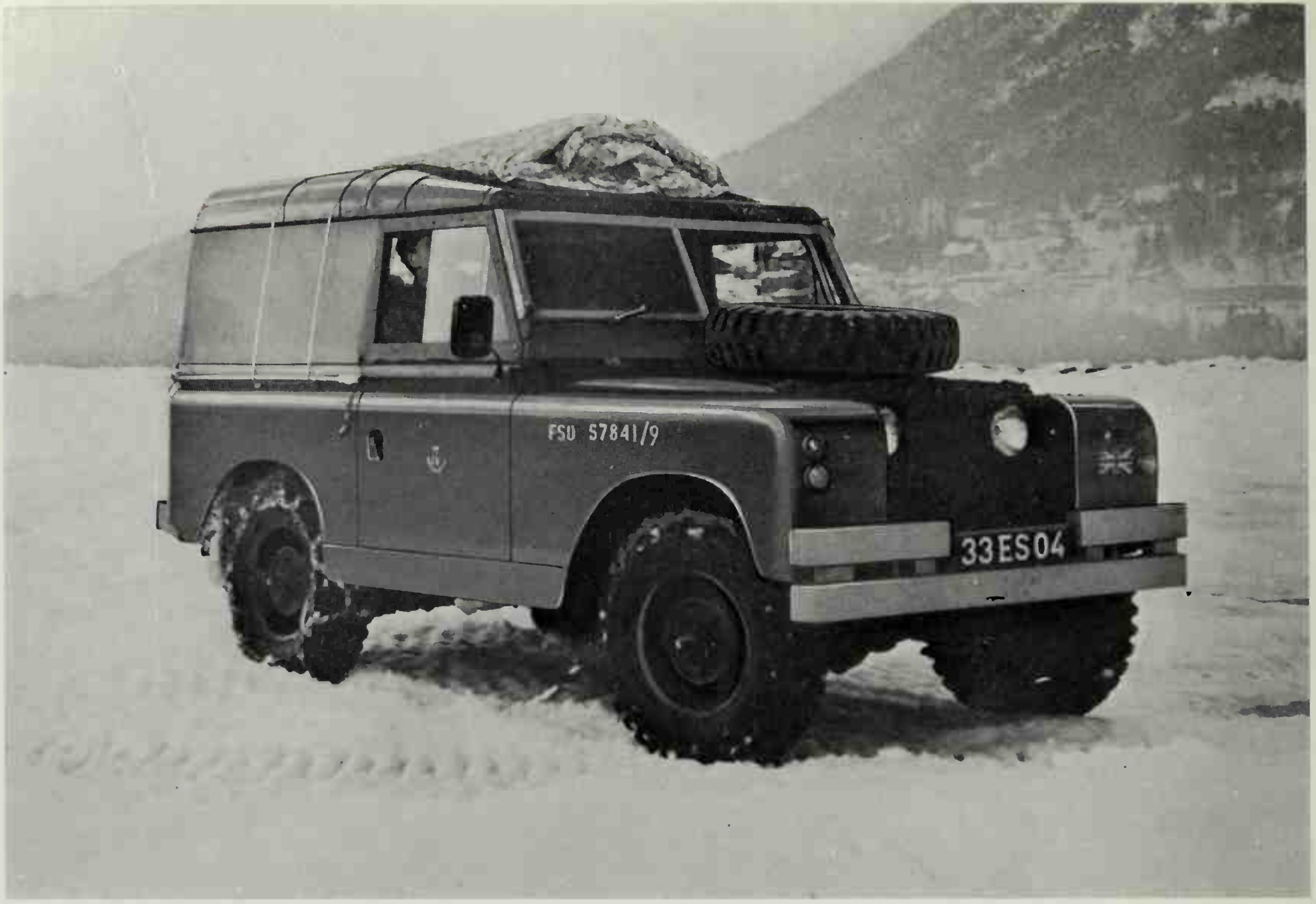
High	1·148:1
Low	2·4:1

Axle ratio—front and rear: 4·7:1

Equipment
Tyre size: three alternatives: 7·50 × 16in **or** 8·20 × 15in sand tyres **or** 9·00 × 15in sand tyres
Wheel rim size: 5·50 × 16in well base
Electrical system: 12V dc (24V ac 90A optional)

Performance
Approach angle (laden): 47 deg
Departure angle (laden): 29 deg
Payload, including crew (road and cross-country): 765kg (15cwt)
Maximum speed, four-cylinder petrol: 96km/h (60mph)
Gross power/weight ratio (laden): 30·8bhp/ton
Maximum tractive effort (laden): 1600kg (3500lb)

THE ROVER COMPANY LIMITED
Meteor Works, Lode Lane, Solihull, Warwickshire, England
Telephone: 021-743 4242 Cables: Rover Solihull Telex: 33156



The standard wheelbase Land Rover (223 cm, 88 inch) shown above can be put to a wide range of uses and is in service with many military and police forces throughout the world, some of which are illustrated below: **1** as two-stretcher ambulance, **2** fitted for radio (FFR), deep-wading, **3** as used in the Australian Army, **4** as a cargo carrier, **5** as a recovery vehicle, **6** on air-drop platform (with $\frac{1}{2}$-ton model), **7** as command post, **8** as used by the Royal Air Force, and **9** at the headquarters of Northag.

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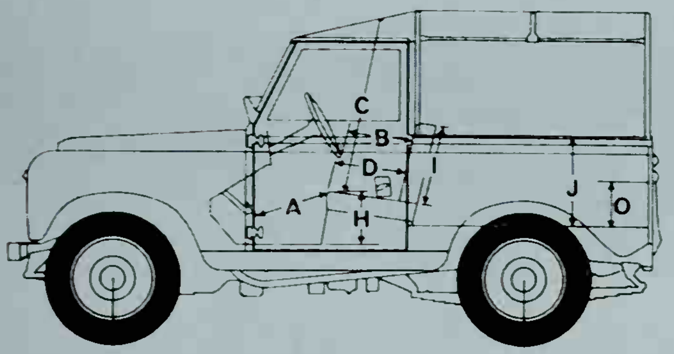
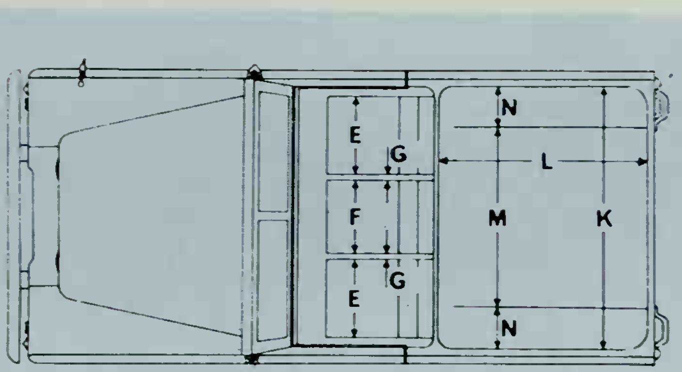
Land Rover

military ½-ton model

In operation with armed and police forces throughout the world, the adaptability and immense strength of the 223-cm (88-in) wheelbase Land Rover have proved it one of the finest general-purpose military vehicles ever produced. The specification includes FV design towing hook, twin fuel tanks, vehicle lashing eyes at front and rear, freight lashing cleats in body, rear bumpers and front bumpers modified to permit pushing of one vehicle by another, oil cooler and eight-bladed fan, FV pattern lights, etc. The vehicle is available in both '12-volt cargo' and '24-volt fitted for radio' (FFR) specifications. The FFR version incorporates a 90A rectified ac electrical system with provision for charging wireless batteries, full suppression of electrical equipment, wireless table, battery carrier, two 100Ah batteries, co-axial aerial leads, HF aerial brackets, operators seats, etc.





		Metres	Inches
	Wheelbase	2·23	88
	Track	1·31	51·50
	Overall length	3·62	142·56
	Overall width (over hinges)	1·68	66
	Overall height of windscreen	1·714	67·5
	Overall height with hood	1·97	77·50
A	Front cushion to accelerator pedal	0·489	19·25
B	Front squab to steering wheel	0·368	14·5
C	Headroom front seat (uncompressed)	0·965	38
D	Front to rear of front cushion	0·400	15·75
E	Width of front cushion	0·457	18
F	Width of front centre cushion	0·381	15
G	Width between front seats	0·025	1
H	Top of front cushion to floor	0·362	14·25
I	Front squab height	0·451	17·75
J	Height of body sides	0·508	20
K	Width of body interior	1·448	57
L	Length of body interior	1·206	47·50
M	Interior body width between wheel boxes	0·917	36·125
N	Width of wheel boxes	0·349	13·75
O	Height of wheel boxes	0·216	8·50

Specification

General
Loading area: 1·43 × 1·22m (56¼ × 48in)
Ground clearance (laden): 0·203m (8in)
Turning circle: 11·58m (38ft)
Unladen weight: 1530kg (3375lb)
Gross vehicle weight (approx): 2020kg (4453lb)

Engine
Type: 2·25 litre, four-cylinder petrol

Transmission
Main gearbox ratios:

Top	direct
Third	1·512:1
2nd	2·22:1
1st	3·6:1
Rev	3·0:1

Transfer box ratios:

High	1·148:1
Low	2·4:1

Axle ratio—front and rear: 4·7:1

Equipment
Tyre size: 6·00 × 16in; 6·50 × 16in; 7·50 × 16in; 8·20 × 15in (sand)
Wheel rim size: 5·00 × 16in well base
Electrical system: 12V dc (24V ac 90A optional)

Performance
Approach angle (laden): 41 deg
Departure angle (laden): 34 deg
Payload including crew (road and cross-country): 508kg (10cwt)
Maximum speed: 105km/h (65mph)
Gross power/weight ratio (laden): 40bhp/ton
Maximum tractive effort (laden): 1800kg (4000lb)

THE ROVER COMPANY LIMITED
Meteor Works, Lode Lane, Solihull, Warwickshire, England
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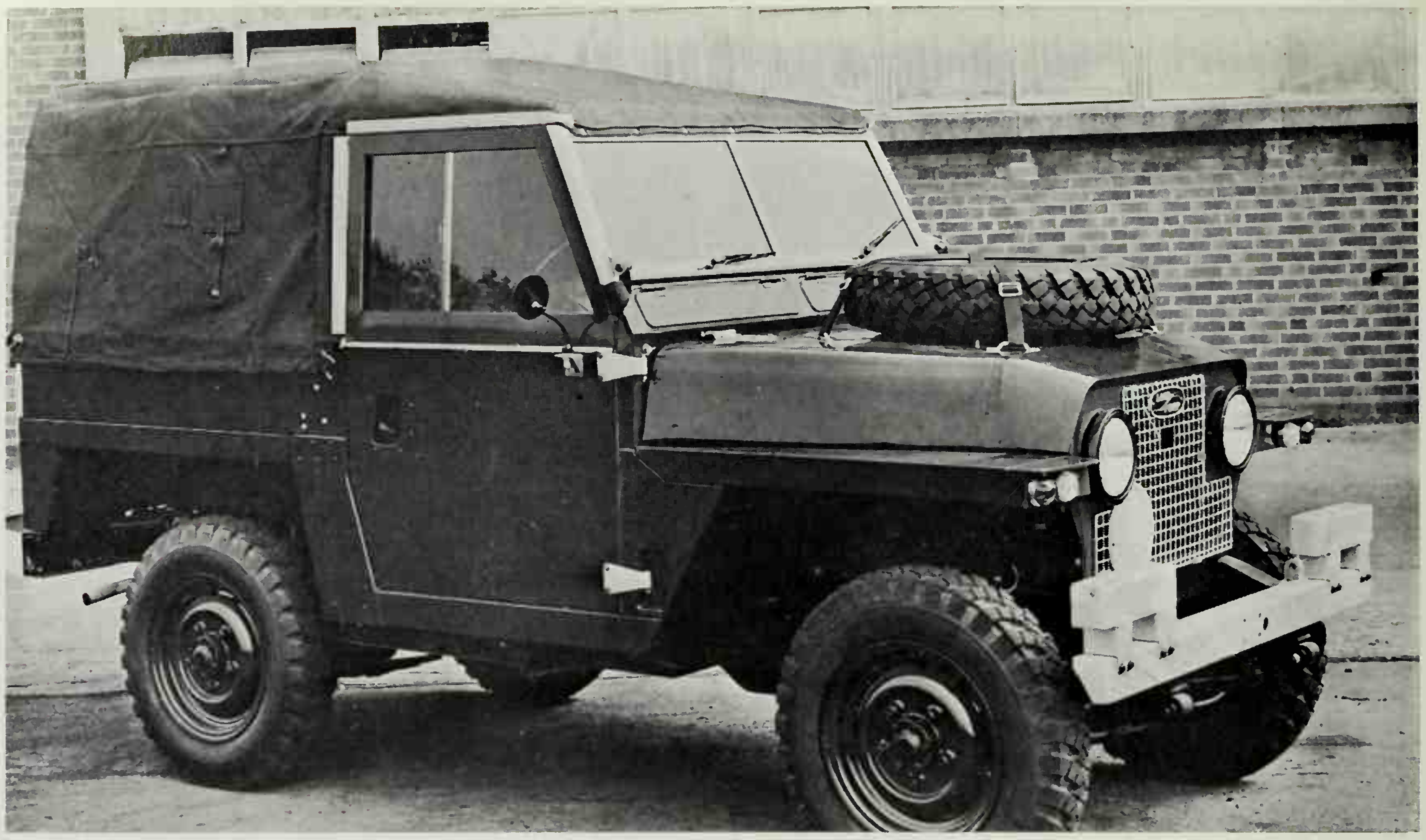
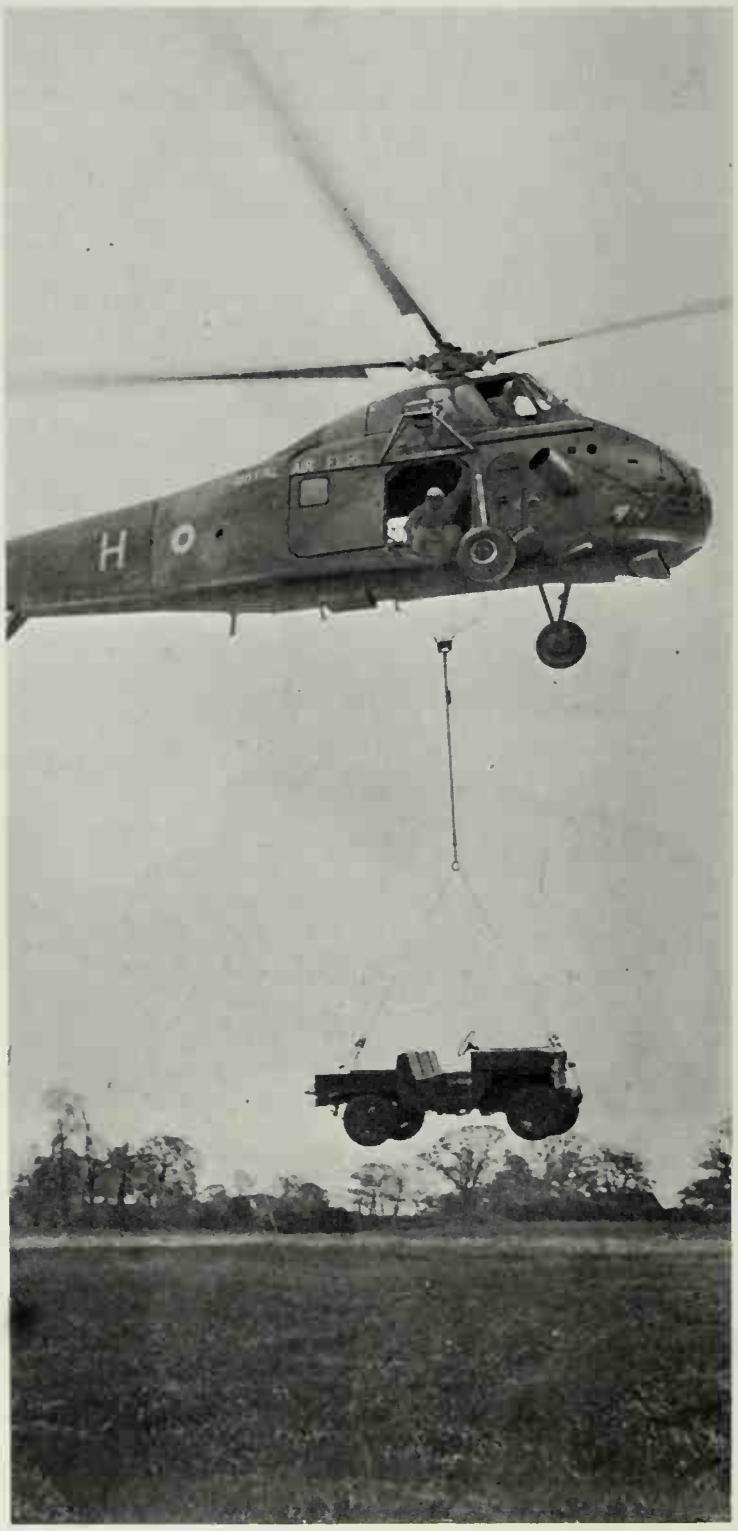
LAND-ROVER

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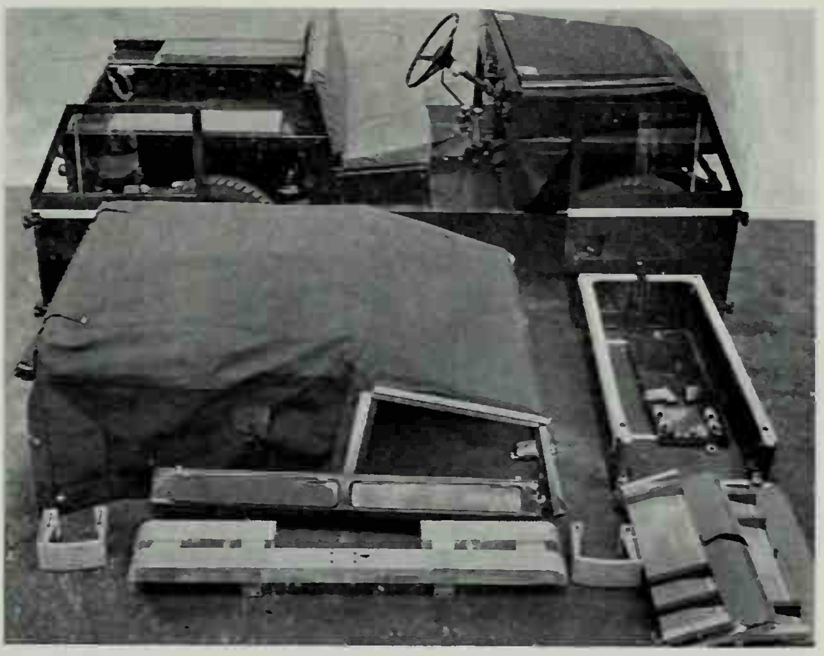
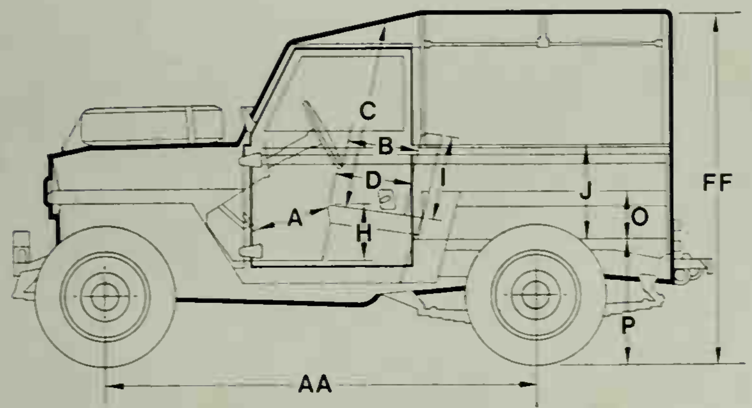
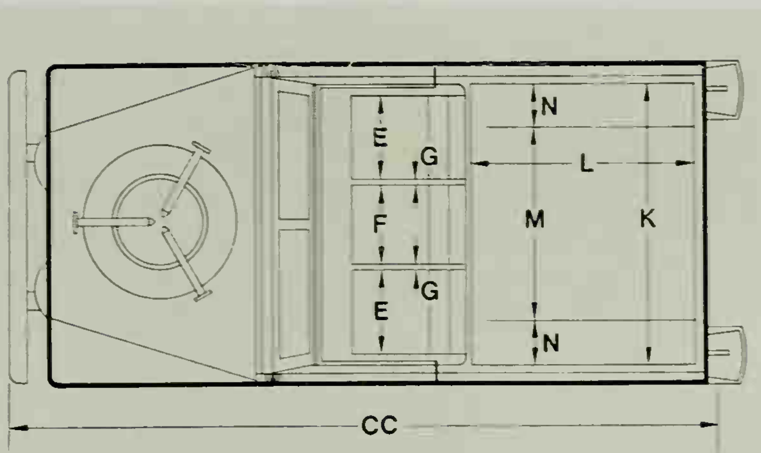
Land Rover

lightweight air-portable model

This new half-ton 223cm (88in) wheelbase Land Rover has been designed and developed in conjunction with the British Fighting Vehicles Research and Development Establishment (FVRDE) to meet the special air-portability requirements of the British Army, RAF and Royal Marines. Over a period it will succeed the normal 88-in Land Rover vehicle which is at present the standard light 4 × 4 in its load class in all British Forces. The main feature of the new half-ton Land Rover is that any or all of the hood, body sides, doors, windscreen, bumpers and spare wheel may be removed more easily for transportation by aircraft or helicopter than from current models, resulting in an austere but highly robust and serviceable vehicle weighing little over a ton. In its built-up form it offers the same degree of comfort and weather protection as existing models. The half-ton is available in both '12-volt cargo' and '24-volt fitted for radio' (FFR) specifications.







		Metres	Inches
AA	Wheelbase	2·23	88·00
BB	Track	1·31	51·50
CC	Overall length	3·65	144·00
DD	Overall width	1·52	60·00
EE	Overall height of windscreen	1·70	67·00
FF	Overall height with hood	1·95	77·00
A	Front cushion to accelerator pedal	0·44	17·50
B	Front squab to steering wheel	0·36	14·25
C	Headroom, front seat (uncompressed)	1·05	41·50
D	Front to rear of front cushion	0·43	17·12
E	Width of front cushion	0·45	18·00
F	Width of front centre cushion	0·45	18·00
G	Width between front sets	0·02	1·00
H	Top of front cushion to floor	0·35	14·00
I	Front squab height	0·45	18·00
J	Height of body sides	0·50	20·00
K	Width of body interior	1·50	59·25
L	Length of body interior	1·14	45·25
M	Interior body width between wheel boxes	0·91	36·00
N	Width of wheel boxes	0·28	11·60
O	Height of wheel boxes	0·20	8·12
P	Platform height (unladen)	0·71	28·00

Specification

General
Loading area: 1·21 × 1·40m (48 × 55½in)
Ground clearance: 0·21m (8¼in)
Turning circle: 12·80m (42ft)
Unladen weight: 1386kg (3210lb)
1206·5kg (2660lb) in stripped-down form
Gross vehicle weight (approx): 2018kg (4450lb)

Engine
Type: 2·25 litre, four-cylinder petrol

Transmission
Main gearbox ratios:
Top direct
Third 1·512:1
2nd 2·22:1
1st 3·6:1
Rev 3·0:1
Transfer box ratios:
High 1·148:1
Low: 2·4:1
Axle ratio—front and rear: 4·7:1

Equipment
Tyre size—five alternatives: 6·00 × 16in; 6·50 × 16in; 7·00 × 16in; 7·50 × 16in
8·20 × 15in (sand tyres)
Wheel rim size: 5·00F × 16in well base
Electrical system: 12V dc (24V ac optional)

Performance
Approach angle: 49 deg (58 deg in stripped-down form)
Departure angle: 36 deg (38 deg in stripped-down form)
Payload (road and cross-country): 508kg (10cwt)
Maximum speed: 105km/h (65mph)
Gross power/weight ratio (laden): 40bhp/ton
Maximum tractive effort (laden): 1800kg (4000lb)

THE ROVER COMPANY LIMITED
Meteor Works, Lode Lane, Solihull, Warwickshire, England
Telephone: 021-743 4242 Cables: Rover Solihull Telex: 33156

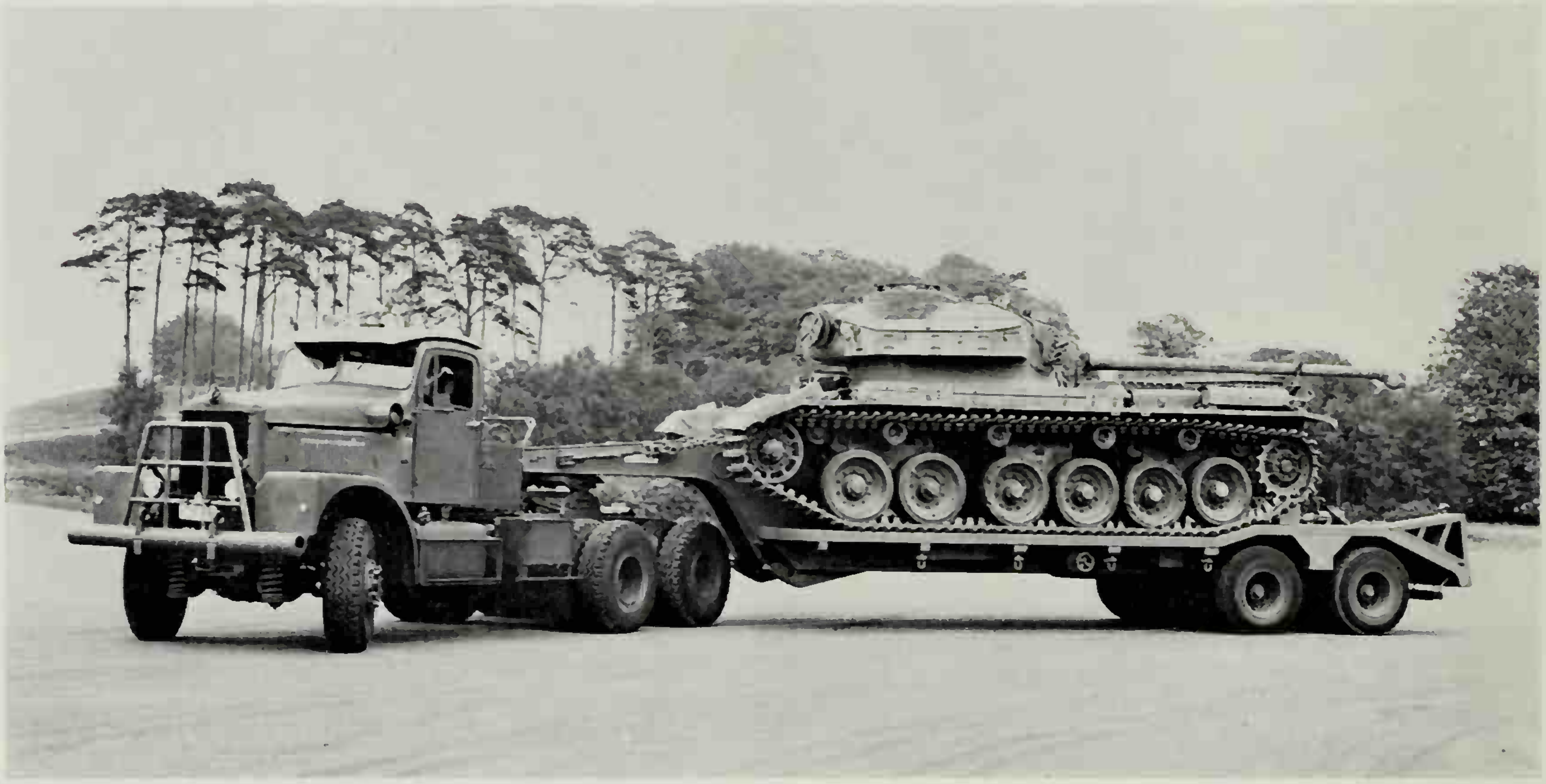
Super Constructor

heavy-duty tractor

The Scammell 6 × 6 Super Constructor is designed to give exceptional performance with heavy loads over all types of terrain. This is achieved by the well-proven Scammell method of transmission and suspension and by power steering and two-pedal control. Gear changes up or down at full engine torque are made by moving a lever on the steering column, the gear selected being shown on a dial.

Powered by the Rolls-Royce C6 TFL, 12·17 litre engine producing 275 bhp, the Super Constructor is available in wheelbase length of 5·81 m (17 ft 2½ in) as three main types: tractor for drawbar trailers with gross train weight up to 180 tons; prime mover for use with semi-trailers for payloads up to 75 tons; chassis for recovery workshops.

It is also available as a heavy-duty wrecker/recovery vehicle with 12-ton capacity Reynolds Boughton equipment described elsewhere in this Catalogue.



Prime mover

6 × 6 Scammell Super Constructor for 50-ton trailer tank transporter

This six-wheel drive vehicle is the motive unit for a 50/60-ton semi-trailer. The cab accommodates two passengers in addition to the driver. A 15-ton winch with 137 m (450 ft) of rope is fitted for loading the semi-trailer and for self-recovery.

Dimensions
Height: 3·04 m (10 ft 0 in)
Width: 3·30 m (10 ft 10 in)
Track, rear: 2·48 m (7 ft 9½ in)
Wheelbase: 5·35 m (17 ft 2½ in)
Unladen weight: 14 532 kg (32 480 lb)

Power unit
Type: Rolls-Royce C6 TFL oil ignition
No of cylinders: 6
Capacity: 12·17 litres
Gross bhp: 275
Gross torque: 103·691 kgf m (750 lbf ft) at 1300 rev/min
Governed speed: 2100 rev/min
Cooling: pressurised
Lubrication: forced feed wet sump

Transmission
Fluid coupling: Fluidrive Type 550 stepped coupling
Gearbox: RV30 air-operated with 8 forward and 2 reverse speeds
Propeller shafts: Hardy Spicer
Axles: Scammell double reduction spiral bevel and epicyclic fully floating driving axles with disengageable drive to front axles. Ratio 10·25:1

Wheels
Rims: 4·06 × 5·08 m (16·00 × 20·00 in)
Tyres: Michelin Sahara X. Spare wheel and tyre supplied loose

Brakes
Foot: two-line air system
Mechanical: rear bogie

Steering
Cam and double-roller with hydraulic power-assistance

Suspension
Front: coil
Rear: balance beam

Fuel tanks
Twin 455 litre (100 gal) tanks fitted to frame

50-ton semi-trailer tank transporter

This semi-trailer, with the Scammell Super Constructor 6 × 6 tractor, forms a transportation unit for the movement of tanks, armoured fighting vehicles and miscellaneous stores and equipment up to 50 tons.

Dimensions
Height: 2·62 m (8 ft 7 in)
Width: 3·35 m (11 ft)
Length: 11·77 m (38 ft 7½ in)
Wheelbase (to kingpin): 8·66 m (28 ft 5 in)
Track: inner 0·91 m (3 ft); outer 2·74 m (9 ft)
Platform height: 1·17 m (3 ft 9¾ in)
Weight: unladen 16 205 kg (35 728 lb); laden 77 219 kg (170 240 lb)

Wheels
Rims: 0·95 × 0·51 m (37·5 × 20 in)
Tyres: E 20 Michelin Metallic

Jacking
Manually operated hydraulic jacks

Suspension
Unsprung walking beam

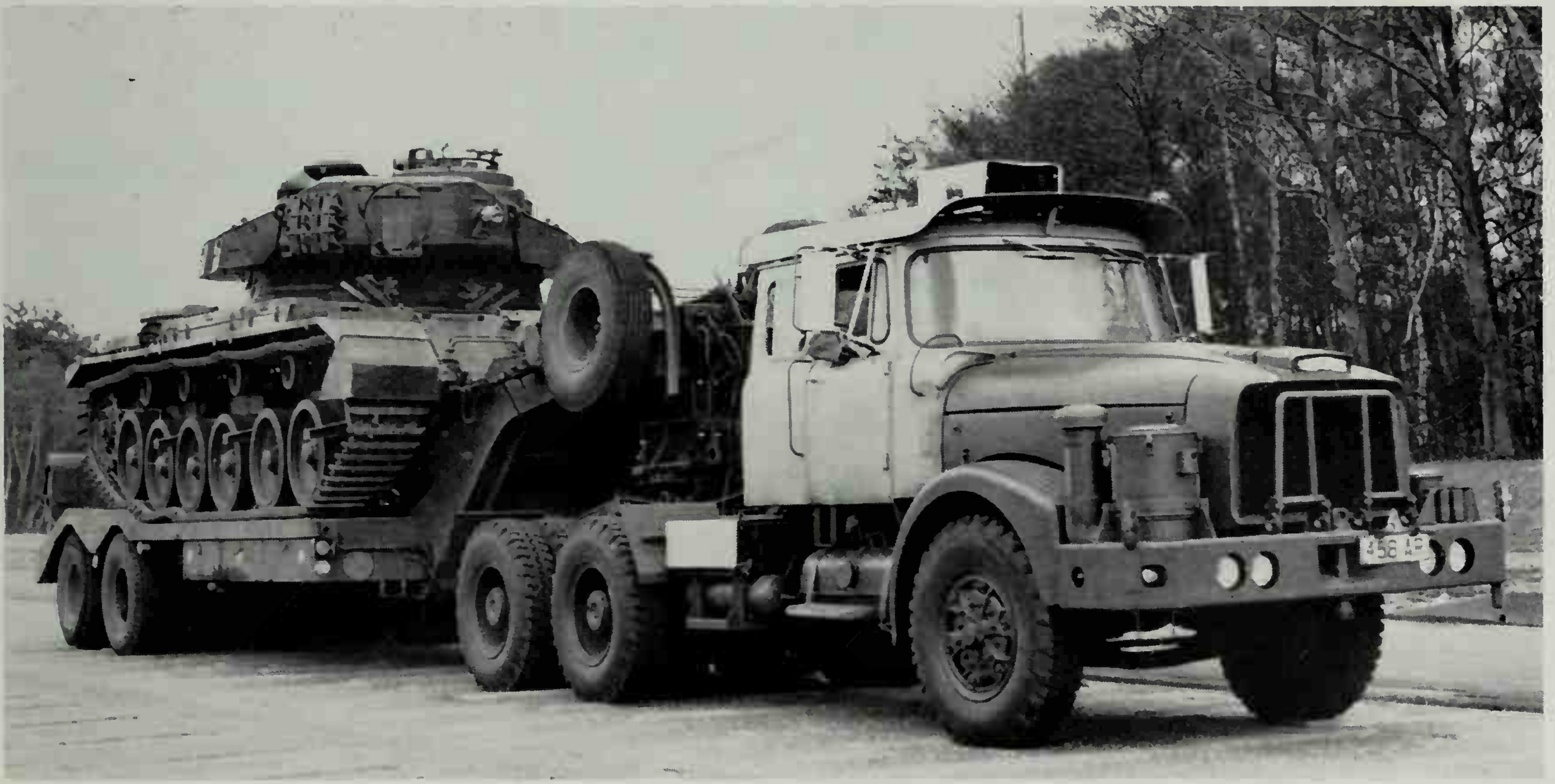
Towing attachments
Kingpin size: 89 mm (3½ in) dia

Contractor

high-speed heavy-duty tractor

The Contractor is not just one truck but a whole range of vehicles for high-speed long-distance road haulage. It is available with different capacity rear bogies, alternative engines and gearboxes for gross combination weights of 75 tons and more. Contractor performance ranges in speed from 80–96 km/h (50–60 mph); gradient ability is 1 in 4 (depending on choice of engine, gearbox and rear bogie); payloads of 60 tons or more can be carried. The specification and performance details quoted here are typical and intended as a guide only—they do not indicate the full extent of the range of performance.

The Scammell Contractor is built to order to meet particular requirements and needs. Each truck is designed and equipped to suit a specific purpose.



Specification

Engine
Cummins NTC-335 six-cylinder diesel engine producing 335 bhp at 2100 rev/min. Torque 129 kgf m (930 lbf ft) at 1600 rev/min

Clutch
Lipe-Rollway twin plate 381 mm (15 in) dia with solid centre plates. Type No 15-2DP. Hydraulic actuation with Clayton 'Airpak' booster

Gearbox
Fuller RTO-913
Ratios: 12·50:1   8·35:1   6·12:1   4·56:1
3·38:1   2·47:1   2·14:1   1·81:1
1·57:1   1·35:1   1·17:1   1·00:1
0·87:1
Reverse: 13·07:1
3·87:1

Brakes (front)
Leading and trailing shoe type, operated by S-cams with cam levers operating through slack adjusters. Diaphragm type 24 actuators operate the cam levers.
Size of brake: 431 × 152 mm (17 × 6 in) × 16 mm (⅝ in) thick

Brakes (rear)
Design as for front brakes. Diaphragm type 30 actuators
Size of brake: 457 × 203 mm (18 × 8 in) × 19 mm (¾ in) thick

Brakes, air pressure system
The engine-driven compressor is regulated by a built-in unloader valve, controlled by a governor type D supplied by the main reservoir. The compressor charges the main reservoir, which in turn charges a second reservoir through a charging valve which connects the two reservoirs only above a preset pressure. The main reservoir supplies air to the E-1 type pedal valve which regulates air to all the brakes on the vehicle and to a relay controlling air feed to the service line coupling. The second reservoir supplies air to the valve controlling the spring brakes; it also supplies air for the gearbox control.

A standard two-line air system is employed. Aeroquip (or equivalent specification) brake hoses are used.

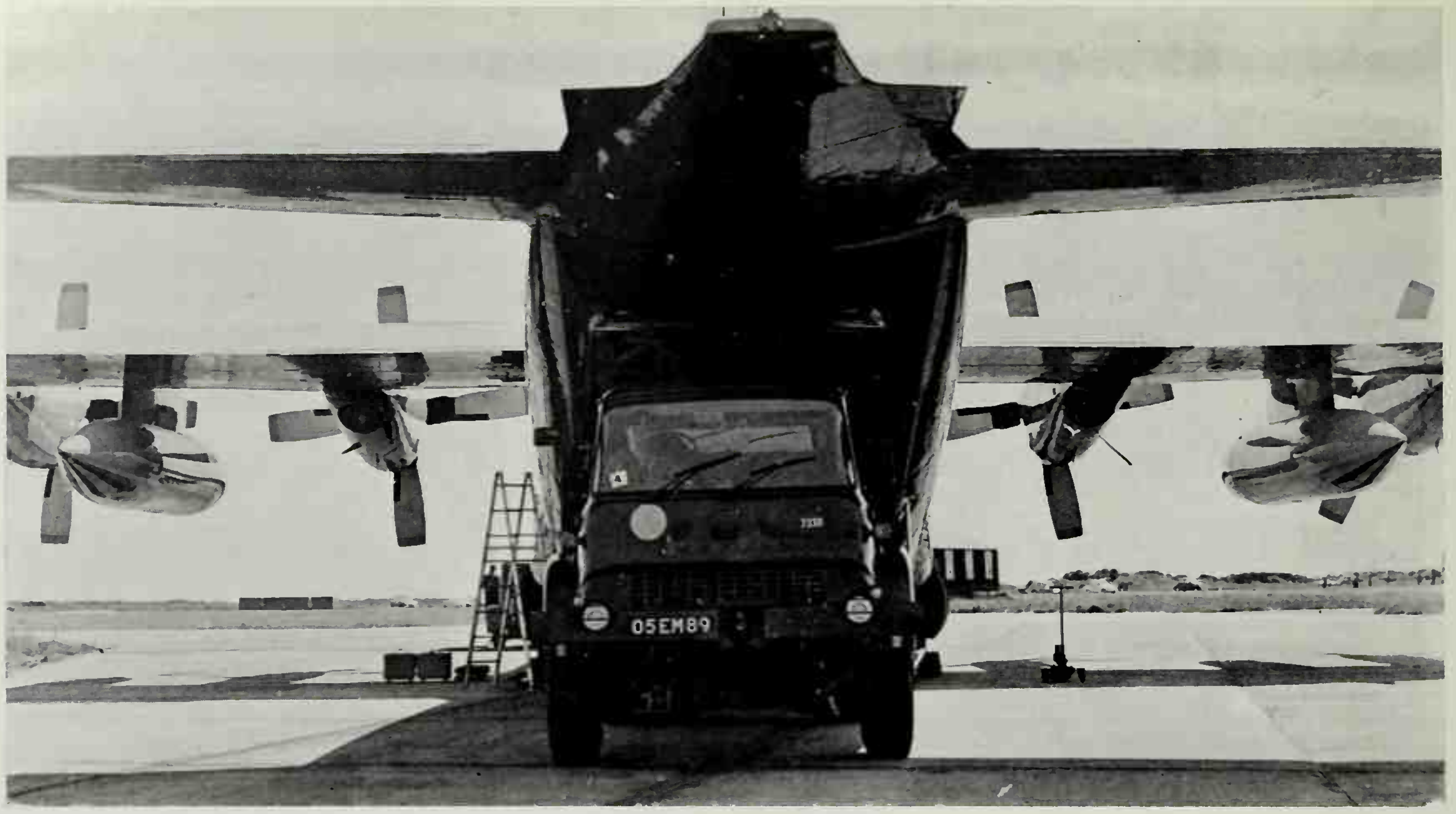
Electrical equipment
A 12 V single-pole system is fitted, with series-parallel switching for the 24 V starter. A battery carrier is mounted on the frame.
Four headlamps of 146 mm (5¾ in) dia are provided, protected by, but mounted independently of, the front bumper.
Two forward facing side lamps
Contour lamps: two amber, facing forward, on cab roof at front corners
two red, at front sides
Two combined stop-and-tail lamps, two flashing turn indicators at front corners.
Two lighting switches: one controlling headlights, the other controlling side, tail and marker lights only

Wheels
10,00W × 24 in with 8·75 in offset

Tyres
14·00-24 in × 20-ply rating, ten per vehicle

SCAMMELL LORRIES LIMITED
Military Sales Division
Berkeley Square House, Berkeley Square, London W1, England
Telephone: 01-499 6050   Cables: Leymotors London W1 Telex   Telex: 22498

BRITISH
LEYLAND



The Bedford MK general-service vehicle has a low overall height, which gives excellent air-portability characteristics and renders it ideal for easy concealment. It is at home on all types of terrain

New wide track, high ground clearance, good belly clearance and an unprepared fording or wading ability up to 760 mm (30 in) provide even greater versatility and efficiency than with the widely known R-type Bedford

Four-wheel drive is now available on the MK chassis in both 'high' and 'low' transfer box ratios, and ratio changes can be made without stopping the vehicle. Handling and performance are even better than with the Bedford R 4 × 4

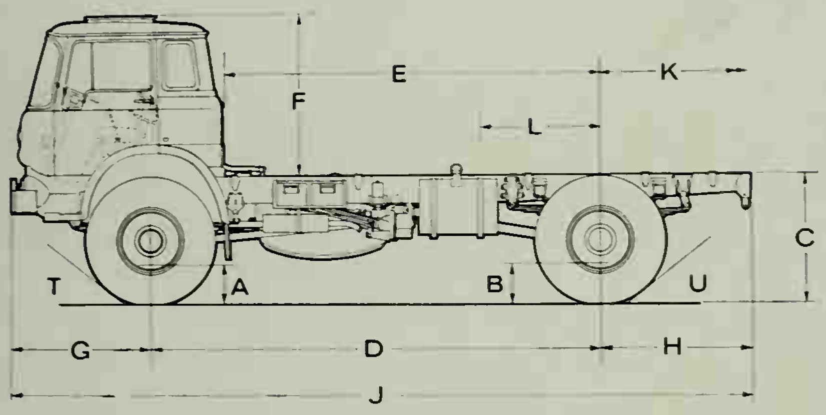
Bedford MK

general service truck

Latest in a range of very successful cross-country 4 × 4 vehicles from Bedford, which have been in continuous production for over 30 years, the new M-type Bedford 4 × 4 truck offers many new features and improvements:

(1) The completely new 'cab-ahead-of-engine' layout gives very much improved crew accommodation, unobstructed cross-cab access and reduced step height; (2) the redesigned transfer box provides four-wheel drive in both 'high' and 'low' ratios, with two-wheel drive in 'high' only; (3) higher gross ratings mean increased load capacity; (4) the exceptionally wide track gives improved stability on rough terrain; (5) there is a completely new braking system with dual air and dual hydraulic operation, or with three-line air for trailer brake operation; (6) vehicle height and weight are low for air-portability.

Specification variations can be provided for special applications. Power units can be for petrol, diesel, or multi-fuel operation.



Dimensions

A— 343 mm (13·5 in)
B— 343 mm (13·5 in)
C—1079 mm (42·5 in)
D—3962 mm (156·0 in)
E—3251 mm (128·0 in)
F—1422 mm (56·0 in)
G—1235 mm (48·62 in)
H—1333 mm (52·50 in)
J—6530 mm (257·12 in)
T—41°
U—38°

Unprepared wading (shallow fording) 762 mm (30 in)

Weights

	Single rear wheels			Dual rear wheels		
	kg	lb	ton	kg	lb	ton
Gross vehicle weight	9450	20 832	9·30	11 175	24 640	11·00
Gross train weight	14 734	32 480	14·5	—	—	—
Kerb weight: front axle	2464	5432	2·43	2412	5318	2·37
rear axle	1270	2800	1·25	1400	3086	1·38
total	3734	8232	3·68	3812	8404	3·75
Body and payload capacity without trailer	5716	12 600	5·62	7363	16 236	7·25

Note—The above are estimated weights in dry condition

Specification

All data given are for the standard MK type with multi-fuel engine and single rear wheels

Power unit
Type: 330 in^3 (5·4 litres) Bedford tri-fuel
Displacement: 5420 cm^3 (330 in^3)
Gross bhp: 107 at 2800 rev/min
Net torque: 30·4 kgf m (220 lbf ft) at 1600 rev/min
Governed speed: 2800 rev/min
Ignition type: compression ignition

Fuel system
Type: electrical lift pump
Types of fuel: AVTAG, AVTUR or DIESO
Air cleaner: FV oil-bath with pre-cleaner
Tank capacity: 150 litres (33 gal)

Engine lubrication
System: wet sump

Engine cooling
System: pressurised, with pump, fan and thermostat

Wheels
Rims: B8·0 × 20 4·4 offset ten-stud heavy-duty three-piece
Tyres: 12·00 × 20 14 PR cross-country
Tyre pump: via compressor
Chains: provision for, can be fitted

Transmission
Clutch: 230 mm (13 in) single dry plate
Gearbox: four-speed synchro and reverse
Transfer box: two-speed
Trans box ratios: 2:1 and 1:1
Propeller shafts: Hardy Spicer
Axles: fully-floating
Ratios: top 6·8:1; bottom 96:1
Differentials: two, fully-floating, hypoid
Winch: optional, 5 tons capacity, mid-mounted to permit winching to front and rear

Brakes
Foot: air/hydraulic dual-line drum pattern on all wheels
Parking: drum-type transmission brake on rear-axle casing
Trailer: three-line air
Warning device: gauge, buzzer and lamp

Steering
System: worm and sector
Turning circle: 18·29 m (60 ft) dia

Suspension
Front: semi-elliptic
Rear: semi-elliptic
Dampers: double-acting telescopic front and rear

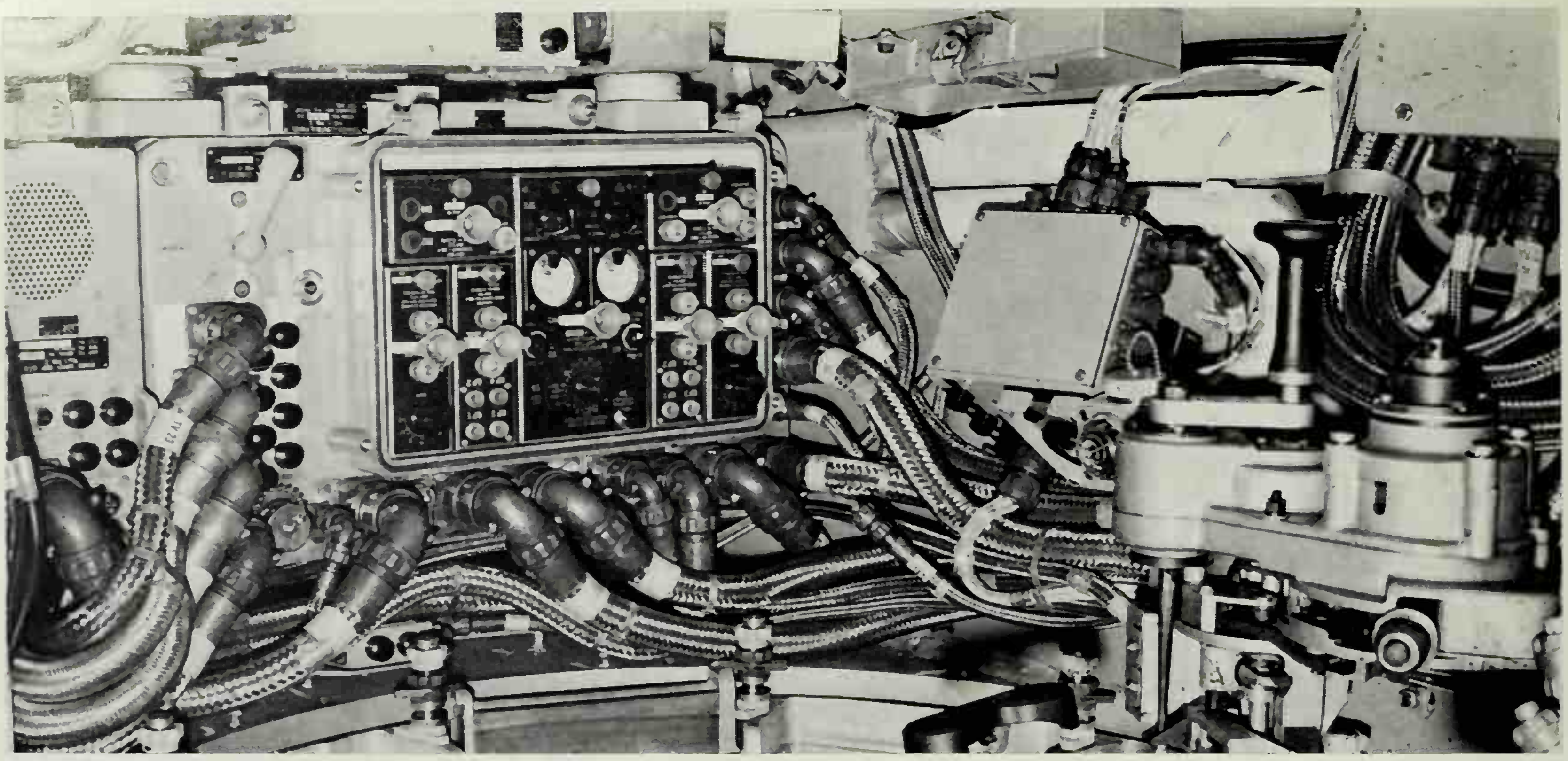
Towing attachments
Type: hook front and rear

Electrical equipment
Alternator: 24 V
Batteries: 2 × 12 V 80 Ah
Suppression: MVEE specification 2051, Appendix D1, schedule B

VAUXHALL MOTORS LIMITED
Luton, Bedfordshire, England
Telephone: Luton 21122 Cables: Carvaux Luton Telex: 82131

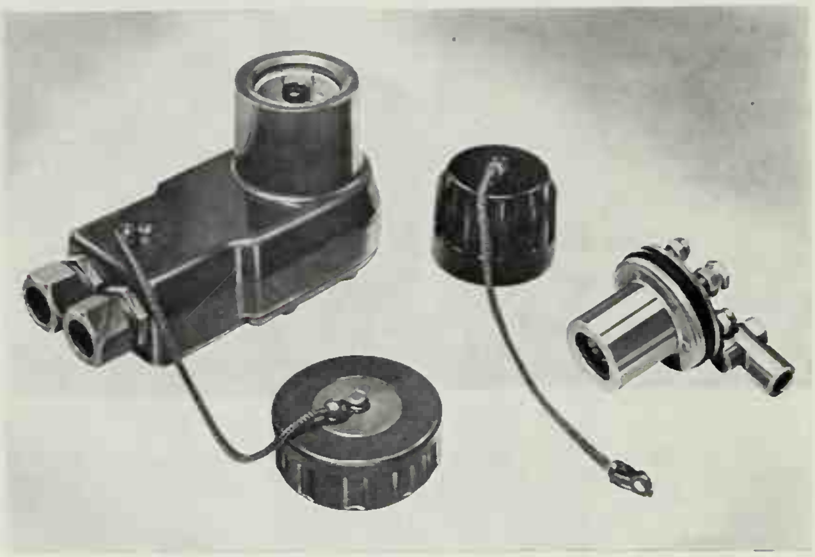
Section 14

Vehicle equipment



Above: many 5MS connectors of different types and sizes are used in the turret of the Chieftain tank to protect all electric cabling

The Pattern 104 connector, showing the latest fully sealed high-density assembly



This inter-vehicle connector is a heavy-duty unit to aid starting at sub-zero temperatures, either by linked distribution systems or slave units

This twelve-point trailer connector is a robust sealed assembly able to meet rough unskilled handling in trailer coupling

Electrical connectors

Multi-pin ordnance types

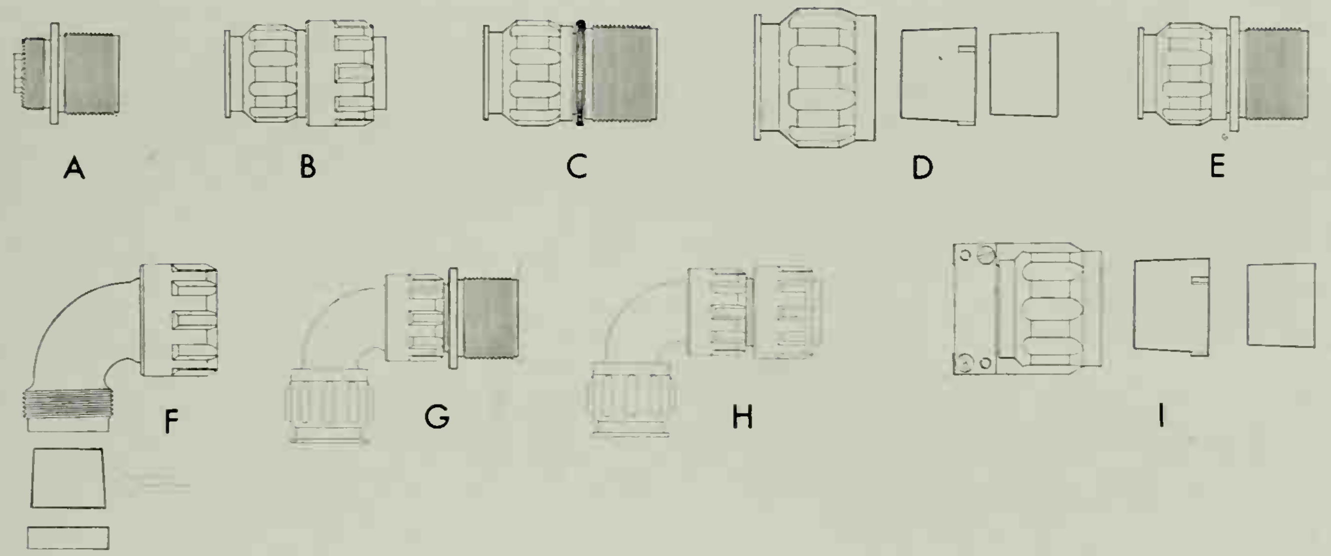
The Connector Division of AB Electronic Components Ltd has for many years designed and manufactured electrical connectors to the exacting requirements of British Government specifications. We are proud to have been associated with the British Military Vehicle Engineering Establishment, formerly FVRDE, for the past five years as design parents for connectors in defence networks, communication systems, and vehicle developments. Our expertise enables us to tackle the most complex applications.

5MS is the nomenclature for the standard range of connectors used throughout the UK in general vehicle wiring. This company played a major part in their design and development. The basis of the concept was the MIL-C-5015 specification but it was updated in line with current connector practice. Bonded and sealed assemblies, using closed entry sockets, are manufactured to more stringent tolerances to ensure interfacial sealing. The concept employs a minimum number of components to produce a fully universal system, with advantages to the engineer, purchasing officer and storeman.

Other ranges available from production include Pattern 104, principally used in radio and signal communication systems. The range is fully approved to specification DEF-5325-2. Pattern 104 connectors have replaced and remain intermateable and interchangeable with Mk 4 connectors, a British Government standard for many years.

During the last two years our R & D team has devoted much time and effort to analysing the feasibility of using 'flat cable'. The advantages of using flat flexible cables, particularly on government/aerospace and defence projects, are well known. Our results from this programme are due to be launched very soon. The concept will provide not only an extremely simple answer for termination and coupling, but is in itself the key to a wiring system.

We are presenting here only the Connector Division of our company. We employ over 2500 people in three modern factories in South Wales, making thick-film circuits, potentiometers, switches and edge connectors; a German subsidiary aids our service to Europe.



The above sketches illustrate the design concept of the 5MS connector series: The basic components are a fixed unit (A), a free unit (B) and a coupler unit (C). If sealing is required on the back of a fixed unit (A), a grommet assembly is used, comprising a grommet, follower and nut (D), to combine into the unit shown at (E). For units requiring a right-angled outlet, an angled outlet set is available comprising an outlet, grommet and follower (F). This results in a fixed angle outlet (G) or in a free angle outlet (H). The outlet with its integral nut is fitted in place of the grommet nut, which then fits on the end of the outlet. Should additional support be required for the cables or any assembly, the grommet nut can be replaced by a grommet cable clamp nut (J)

The following brief details describe some of the many different concepts developed by us specifically for defence applications; full details are available on request.

Intervehicle connector
This provides the link for coupling two vehicle distribution systems to ease starting at sub-zero temperatures. With the introduction of multi-fuel engines came the problems of increased starting current. This concept can handle well in excess of 1000 A for six minutes. It is fully approved by MVEE and NATO STANNAG 4007 and is intermateable and interchangeable with the previous 350 A UK standard.

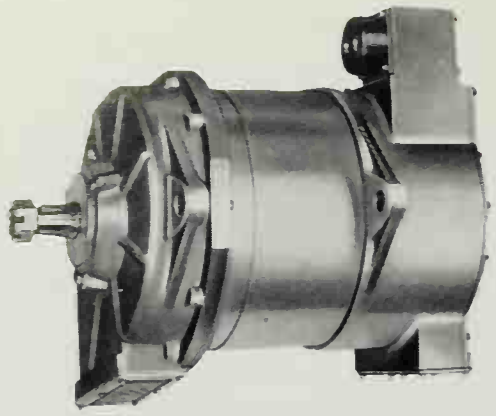
Automatic coupling connector
Produced for coupling the firing circuits for the Swingfire missile. The design overcomes and eases the location problems associated with this form of system.

Twelve-point trailer connector
Fully approved by MVEE and NATO STANNAG 4074, this new design is intermateable and interchangeable with the previous NATO standard. Provision is made for positive cable and conductor sealing, providing fully weatherproof assemblies for both vehicle and trailer. This obviates the hazards of the past with vehicle wading.

Quick release connector
Originally developed for the latest version of the military Brewcan. The canteen connector now has a place at No 1, in the modern fighting services, as important now as in the past. Variations are now installed for other applications on bridge-layer vehicles and Snowcats. The latest form is in the motor racing world for starting Grand Prix cars.

AB ELECTRONIC COMPONENTS LIMITED
Sutherland House, 5–6 Argyll Street, London, W1V 1AD, England
Telephone: 01-437 7581 Telex: 49606

Alternator, type AC140



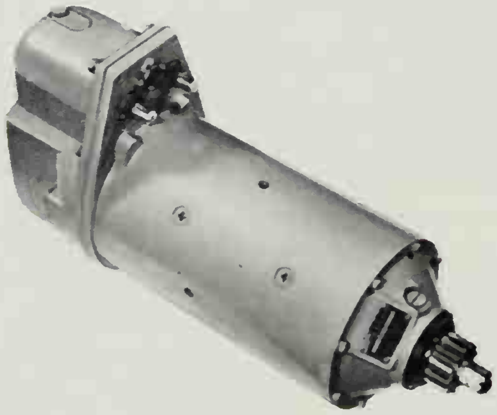
The CAV AC140 alternator has been designed to supply high electrical outputs. It fully meets specification FV2051.

The alternator produces a self-limited maximum output of 140 A at a nominal 24 V at an ambient temperature of 80 C and can operate in an ambient temperature range from –40 C to +80 C, but up to 140 C with forced ventilation, ventilating air being drawn through ducts at an inlet temperature of 60 C. The stator laminations have been cast in position to obtain high thermal efficiency. The insulation in the stator has been designed to withstand high temperatures.

The output from the stator is rectified by the main six silicon diodes mounted in the slip ring end shield. Three additional diodes in conjunction with three of the main diodes provide a rectified auxiliary dc supply for field excitation. Full-load excitation is provided at approximately 2 A field current.

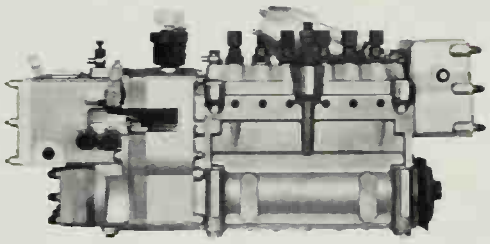
The alternator can be driven in either direction by a shaft or belt. Drive ratio depends on the installation but can usefully be fixed somewhere between 2:1 and 3:1.

Starter motor, type SL6



CAV starter motors come in two types, axial and co-axial. These high-performance starters have been designed to provide maximum efficiency with a long service life coupled to a reliable high duty rating. Pinion engagement occurs under reduced power and full starting torque is not applied until the pinion is completely in mesh with the flywheel ring gear. This positive low-load engagement eliminates any risk of damage as a result of violent engagement. The design incorporates a protection against over-speeding which can occur when an engine is firing and rapidly accelerating and the starter button is held engaged. The starters can operate in a wide variety of climatic conditions and fully meet British military specification FV2051.

Multi-fuel injection pump, type NN



This pump, representative of the CAV range of fuel injection pumps, is for use on six-cylinder multi-fuel engines of 12 litres capacity. As with all CAV injection pumps, this unit has several design features which make it particularly suitable for military applications.

The pump is a totally enclosed and wadable, camshaft type which incorporates its own tappet gear. Lubrication is by engine oil contained in a sump in the base of the pump. The pressure oil from the engine is also used to provide a high-efficiency oil seal on the pump elements to prevent any mixing of fuel and lubricating oil. Accurate governing is provided by a CAV all-speed hydraulic governor with its own lubricating oil supply. The pump can operate, without vapour locks, on all NATO hydrocarbon-based fuels at ambient temperatures from –40 C to 80 C.

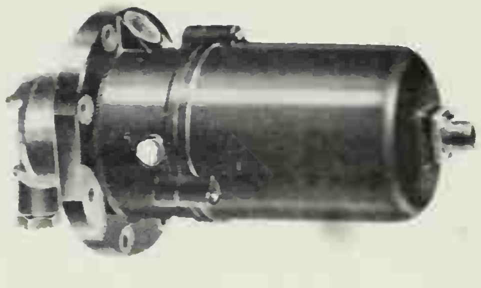
Multi-fuel injectors

CAV manufactures a range of multi-fuel injectors suitable for use on modern multi-fuel compression-ignition engines.

The injector has a dual function to perform if the efficiency of the engine is to be maintained: it has to break up each charge of fuel into a condition suitable for complete and rapid combustion, and it must also direct the spray of fuel into the combustion chamber in a way that ensures that the maximum quantity of oxygen is burnt and that no unburnt or partially burnt fuel is left after combustion to produce unwanted exhaust smoke.

With its unique technical facilities backed by practical experience CAV can supply injectors to meet the most exacting requirement.

Multi-fuel pressurising pump, type PPE 30-25



This is a fuel feed pump for multi-fuel engines where the possible use of volatile fuels needs higher pressures than those of the ordinary mechanically driven feed pump. Electrically driven by a 24 V dc motor the PPE can be driven when the engine is stationary to purge the fuel system of accumulated gas. This positive displacement-type pump can deliver 136 litres per hour at 1·76 kgf/cm^2 and is flange-mounted in the fuel tank. The integral electric motor mounted outside the tank is completely enclosed and is completely sealed against dust and water. It operates in ambient temperatures from –40 C to 108 C and can pump fuel with a temperature ranging from –40 C to 83 C.

Fuel injection systems

and electrical equipment for fighting vehicles

Modern defence strategy created demands for new vehicles incorporating systems requiring constant large power supplies together with an instant and reliable mobility. Participating from the beginning in the search for technical efficiency CAV applied its wide experience and technical know-how of the commercial vehicle industry to initiate a programme combining the design, development and production of a comprehensive range of equipment for fighting vehicles. In this Catalogue it is impossible to detail every item in the range but the representative selection demonstrates the versatility and scope of the equipment offered. The list includes the well-known CAV multi-fuel injection equipment and the extensive range of electrical equipment for fighting vehicles. Each item has been individually designed, developed and built to meet the stringent requirements of British military specifications.

Alternators

This range of ruggedly constructed alternators has been tailored by CAV to meet the exacting requirements of the British military specification FV2051. Designed and developed for a long life with the minimum of servicing these tough machines offer a good power/weight ratio with large electrical outputs.

Rectification is by built-in silicon diodes mounted in the slip ring end shields, the diodes being connected in bridge form between the main windings and the output terminals. The alternators are controlled either by fully transistorised or by electro-mechanical control boards which provide exact regulation of the output, also full screening and interference suppression together with surge protection. If necessary, provision can be made for supplying an ac current from the terminal box.

The special insulation combined with sealed bearings and slip ring compartments allow the alternators to operate efficiently in the extremes of the most arduous climates or environments. With the additional capability of withstanding high thermal shocks, these machines can function satisfactorily submerged in water.

Alternator	**AC524-27**	**AC90-2**	**AC140**
Nominal voltage	24 V	24 V	24 V
Maximum output	25 A	85 A	140 A
Cutting-in speed	1250 rev/min	1000 rev/min	1000 rev/min
Load speed	20 A at 2750 rev/min 25 A at 4250 rev/min	66 A at 2000 rev/min 80 A at 3500 rev/min	115 A at 2000 rev/min 140 A at 3300 rev/min
Rotation	Reversible	Reversible	Reversible
Temperature range	–40°C to +80°C	–40°C to +80°C	–40°C to +80°C
Weight	7·26 kg	18·14 kg	28·12 kg
Control	446 24–7 control box	396–3 control box	468–2 control box

Starters for military diesel engines

Type	**SCA150**	**CA45F**	**MS5**	**SL6**
Nominal voltage	24 V	24 V	24 V	24 V
Power output	2·067 kW	3·728 kW	1·864 kW	11·185 kW
Wiring	IR	IR	IR	IR
Mounting	Flange	Flange	Flange	Cradle
Rotation	Clockwise	Clockwise or counter-clockwise	Clockwise	Clockwise
Weight	10 kg	14·5 kg	16·6 kg	31·7 kg

Control gear in fighting vehicles

A large variety of control and distribution gear has been designed and developed by CAV to meet the precise requirements of the British military specification FV2051. Included in the range of equipment offered by CAV are transistorised and electro-mechanical control boards, interference suppression units, specialised switchgear, solenoids, instrument panels, motors, distribution boxes, junction boxes and control boxes for power and communication circuits. This equipment is installed in existing operational units such as the Chieftain battle tank, FV430 and Saracen APC, Saladin armoured car, Ferret scout car, FFR Land Rover, and GS 4-ton and 10-ton trucks. Equipment for Scorpion and Fox is also available.

Multi-fuel injection equipment

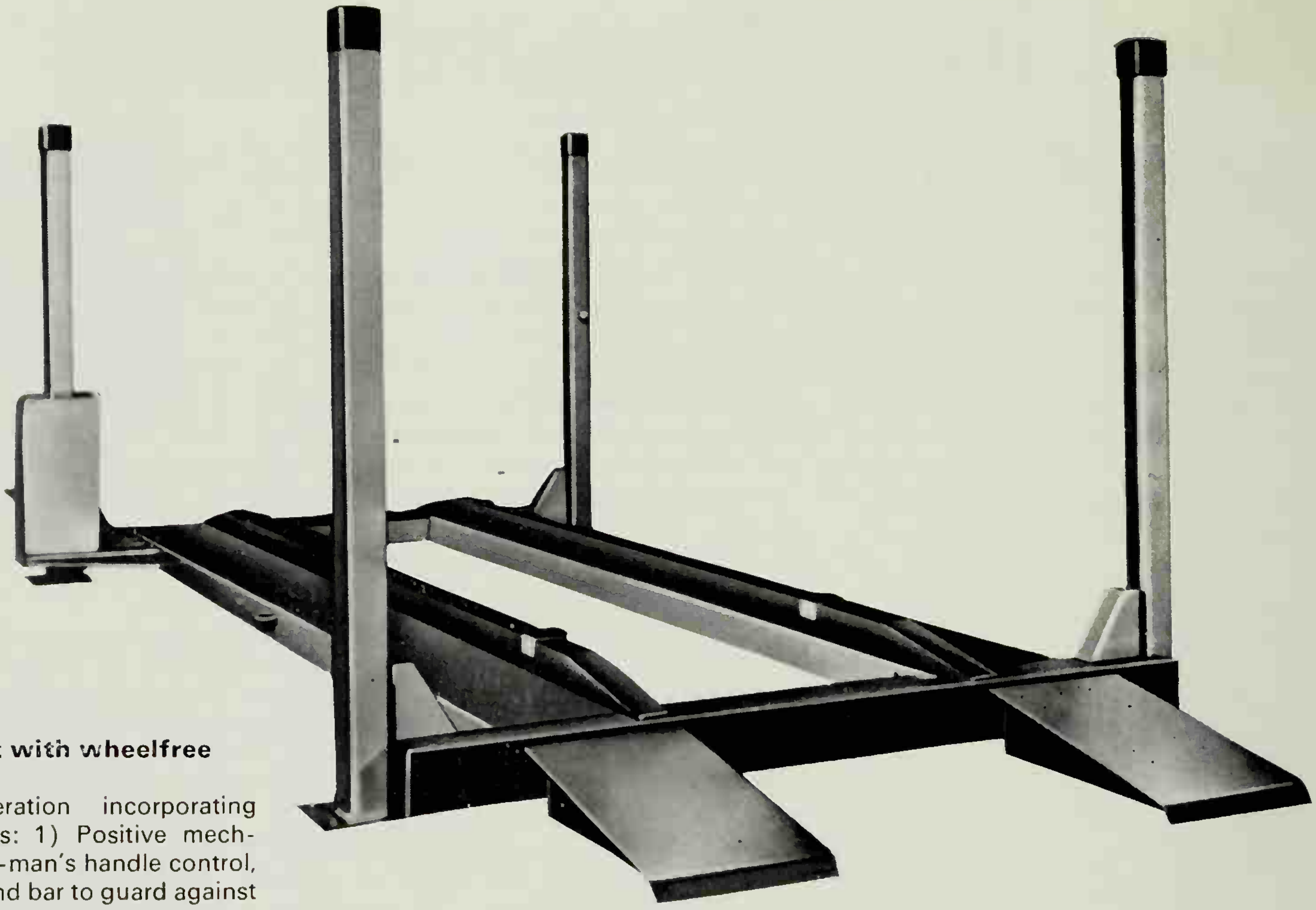
As the largest manufacturer of fuel injection equipment in the world CAV has accumulated a vast reservoir of knowledge and experience of the needs and problems of engine builders and users. This has led to the design and development of a range of fuel injection equipment covering the requirements of a wide range of diesel and multi-fuel engines up to 120 bhp per cylinder.

The list includes a range of fuel injection pumps, governors, fuel injectors, fuel feed and pressurising pumps, and fuel filters. Backed by the most advanced engineering, development and research facilities this equipment has been produced to a standard that makes it automatically acceptable by the requirements of the British military specification FV2051.

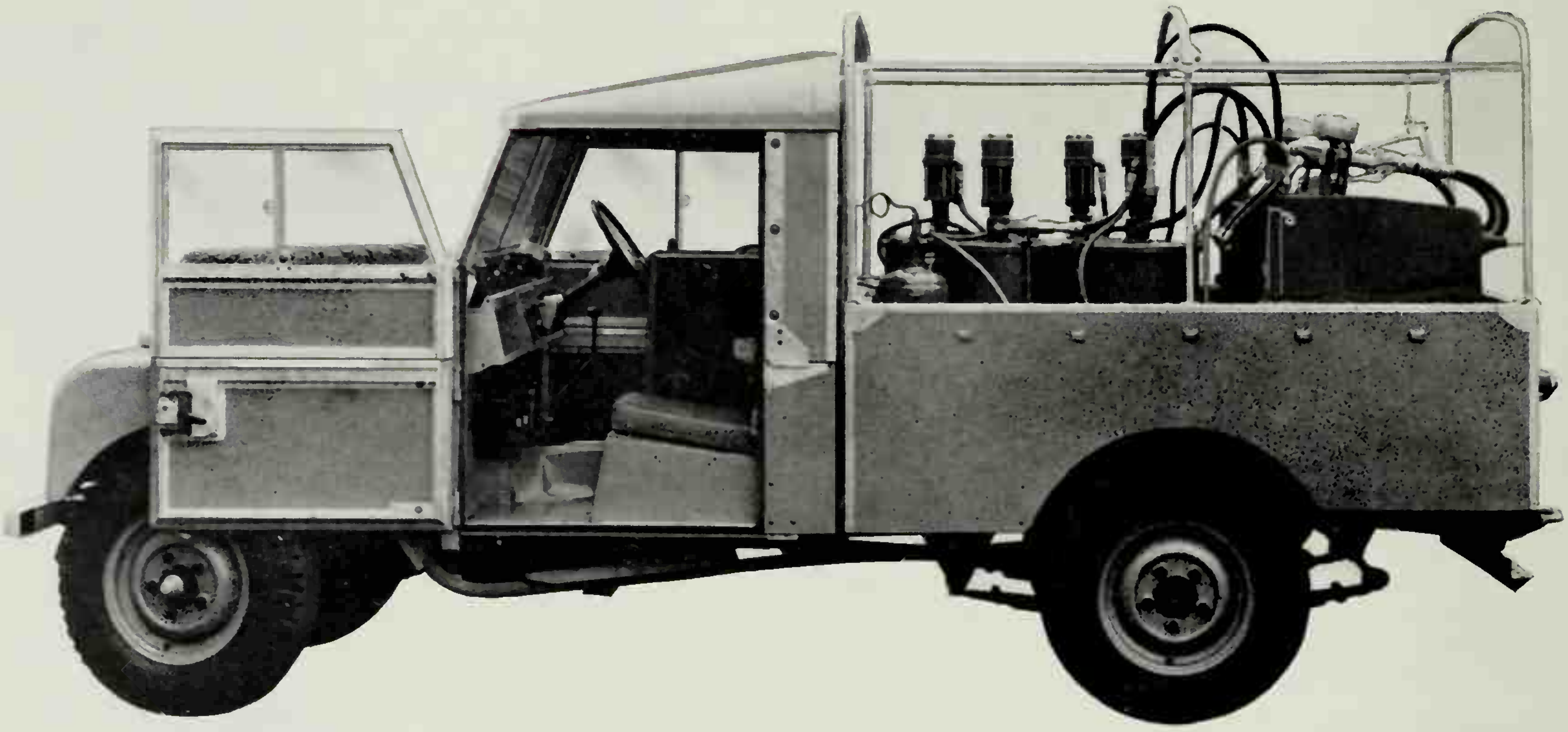
CAV LIMITED
Warple Way, London W3, England
Telephone: 01-743 3111 Cables: Vanteria London Telex Telex: 27881

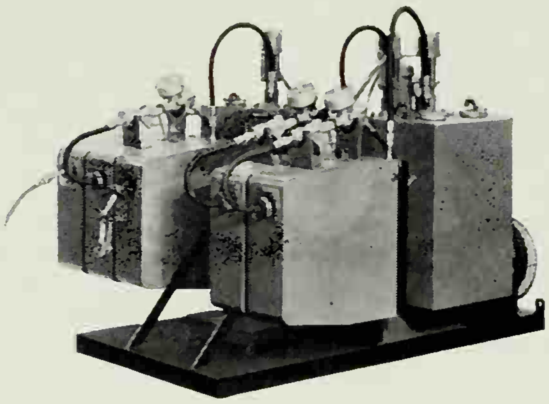
CAV

1966
1967
1969



3-ton capacity lift with wheelfree facility
Hydro-electric operation incorporating three safety features: 1) Positive mechanical lock, 2) Dead-man's handle control, 3) Locking blocks and bar to guard against cable failure.
(Versions with balcony also available.)





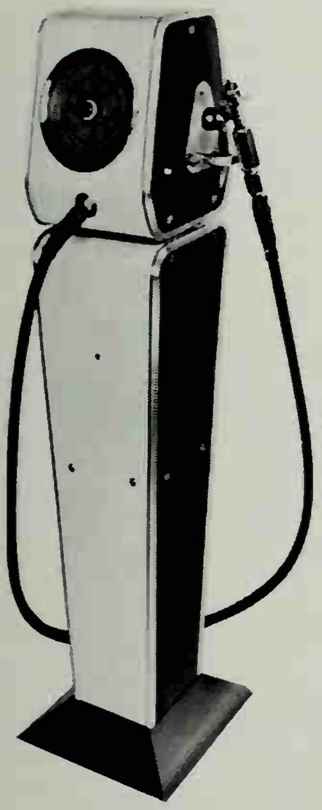
Lubrication service pallets
Various arrangements are available to provide lubrication services for vehicles and plant in the field. Dynaflex specialises in custom-built designs for pallet, skid, vehicle or trailer-mounting

Servicing equipment

for plant and vehicle maintenance

Dynaflex is a leading manufacturer of vehicle and plant servicing equipment with over 30 years' experience and agencies throughout the world. The equipment illustrated here represents only a small part of a variety of units that range from hand-operated oil pumps to sophisticated mobile servicing units.

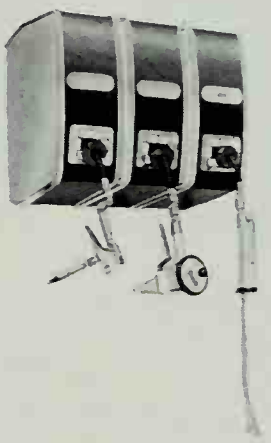
A planning and advisory service is also available to deal with workshop and garage layout and the construction and supply of specialised lubrication equipment for vehicles, plant and workshops.



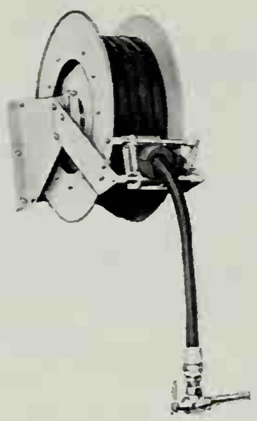
Rotary-head quick-check engine oil dispenser
Can be supplied to operate from compressed air or electricity

High-pressure chassis lubricator (oil or grease)
Models available for operation at 5·6 kgf/cm² (80 lbf/in²) or 10·5 kgf/cm² (150 lb/in²). For dispensing all types of oils and grease

Waste oil system: 55-litre (12-gal) transportable collector and wall-mounted pump unit
For efficient oil waste handling. One pump unit can be used with any number of collector units



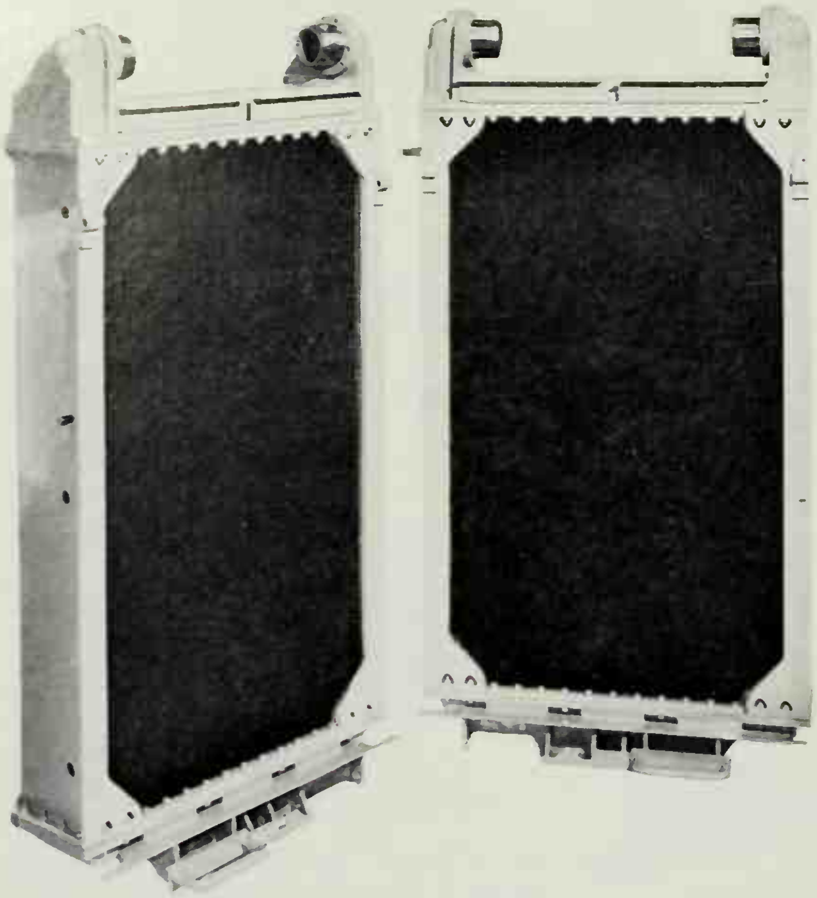
Quickreels
Self-retracting hose-reels for oil, grease, water or air. Can be ceiling, wall or floor-mounted. Approved hose-end meters available in metric or Imperial calibration



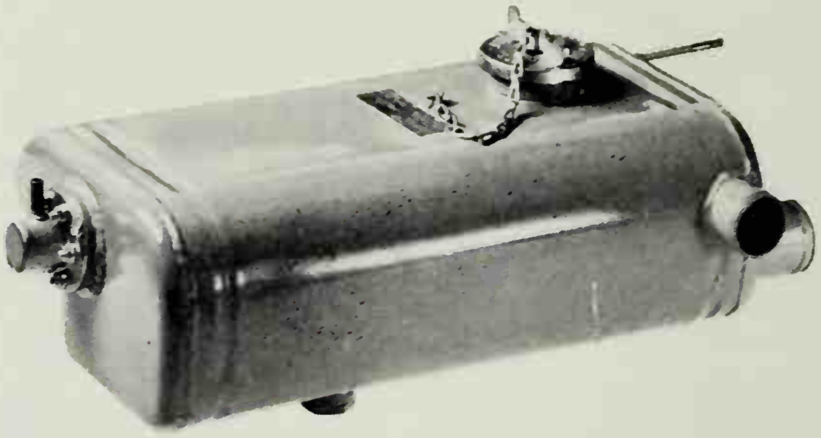
Commercial hose-reel
Features large-bore hose for high delivery rates. Types available for dispensing water diesel fuel or lubricating oils

A Member of Burmah Engineering
DYNAFLEX LIMITED
Dynaflex Division
North West House, 119/127 Marylebone Road, London NW1, England
Telephone: 01-262 5010 Telex: 28694

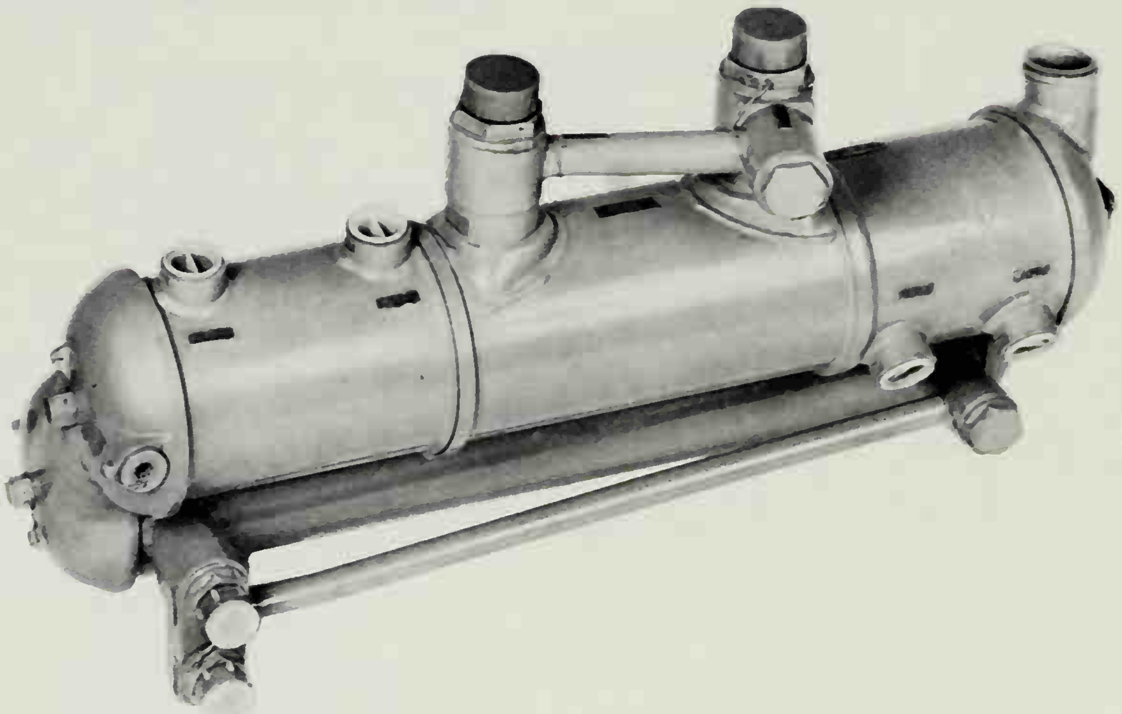
dynaflex



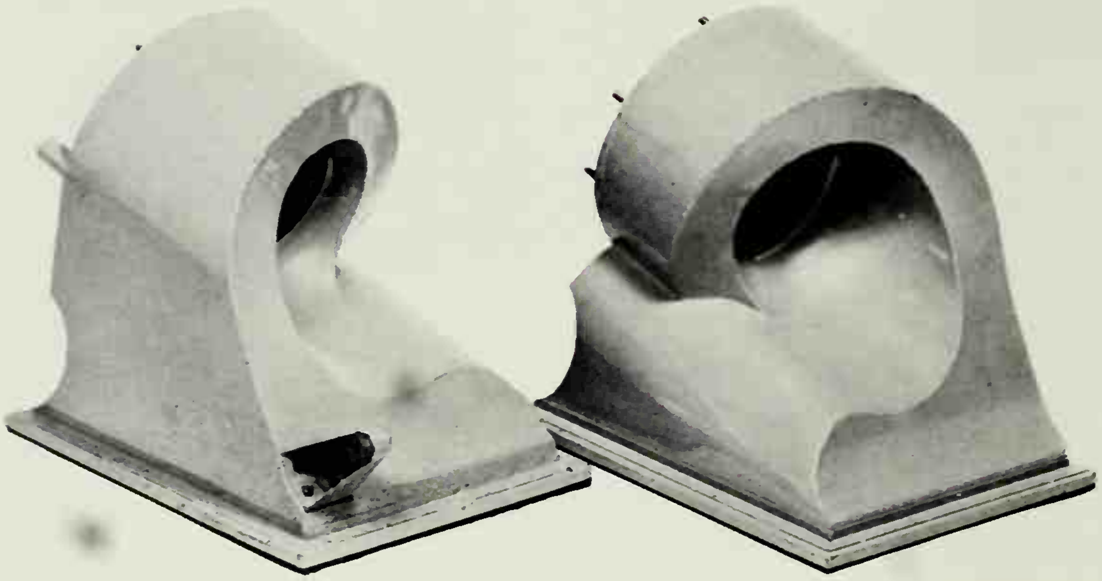
A pair of radiators as fitted to the Chieftain battle tank. Connecting trunnions are finely finished stainless steel to allow the radiators to be swung out, giving access to the engine bay



Combined header and expansion tank as fitted to the Fox armoured car. It is of all-welded construction, complete with pressure-relief valve and filler cap



Heat exchanger as fitted to the FV432 armoured personnel carrier. It has four cooling circuits for engine, gearbox, steering and hydraulic systems oil



High-performance volute casings as fitted to the Fox armoured car. They fit round the centrifugal fans and seal on the outlets from the radiators

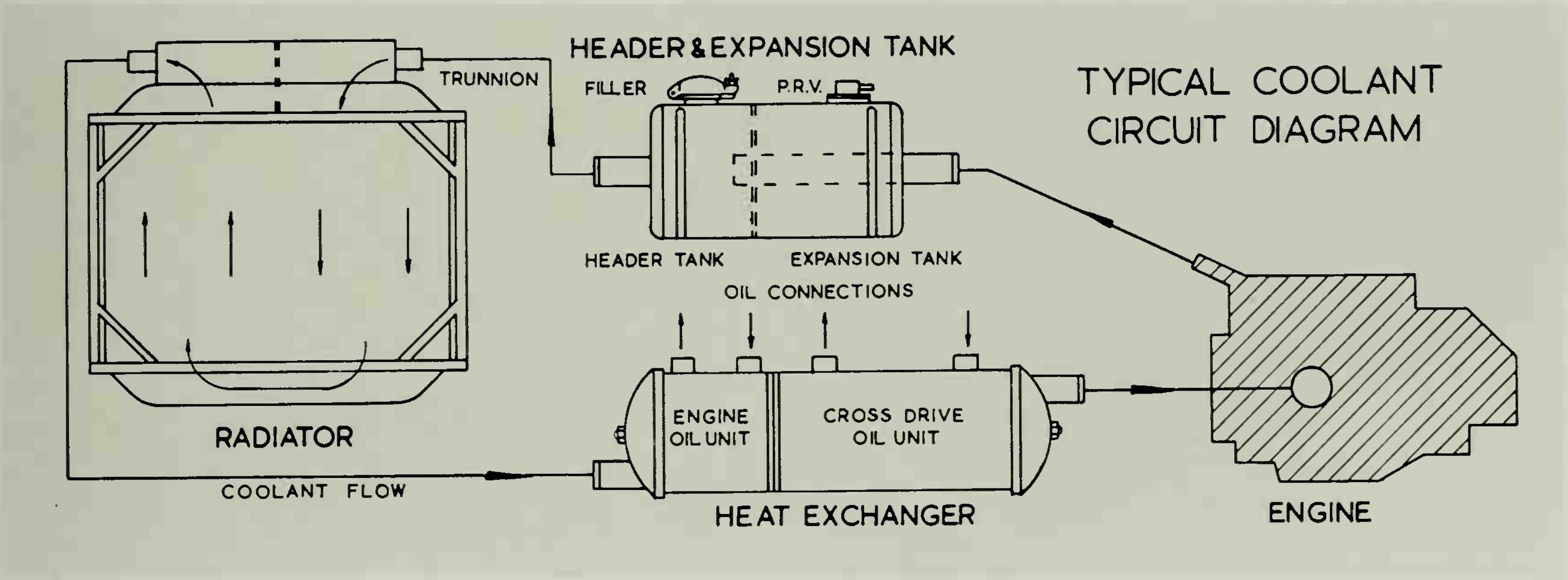
Cooling systems

for military vehicles

Gallay Ltd specialises in the design, development and manufacture of heat-transfer equipment and is a major supplier of cooling systems for military vehicles.

Experience over many years has resulted in the introduction of numerous sophisticated developments to give units that are compact and lightweight yet capable of the high performance, integrity and heavy-duty ratings required under all extremes of operational conditions specified by the British Ministry of Defence. These developments include: all-welded header and expansion tanks constructed to fine limits; multi-purpose in-line heat exchangers derived from a common base to give simplicity in handling and function; a bolted form of radiator that has been perfected with a finely finished stainless steel trunnion and O-ring system to enable it to be swung out of position to afford access to the engine bay without disturbing the coolant system; high-performance volute casings specifically designed for fighting vehicle purposes; improved performance by the persistent use of the latest fabrication processes. All systems are engineered for reliability and ease of routine maintenance or emergency repair in the field.

With development of the new forms of highly mobile lightweight armoured vehicles Gallay is continuing to remain at the forefront by providing highly efficient cooling systems of the type shown.


TYPICAL COOLANT CIRCUIT DIAGRAM

Specifications

Radiators

These are designed to fit the available space. The top tank (with stainless steel trunnions), transfer tank and side plates are of aluminium alloy. The matrix consists of tinned brass tubes, copper fins and brass collector plates at either end. The whole assembly, with suitable gaskets, is bolted together. All radiators are fully tested to British Ministry of Defence specifications for performance and reliability in climatic conditions from −40°C to +50°C. Typical overall heat dissipation at 38°C ambient with 730 litres/min (160 gal/min) coolant flow is 4280 kcal/min (17 000 btu/min).

Heat exchanger

As illustrated, this consists of four separate sections in-line to cool the engine, hydraulic, steering unit and gearbox oils. Each section comprises a bank of 4·8 mm ($\frac{3}{16}$ in) outside dia brass tubes encased in a steel cylinder and sealed at both ends by a steel collector plate. Internal baffles direct oil to be cooled back and forth across the tubes. A viscosity relief valve and bypass tube may be fitted when a maximum working pressure through the heat exchanger is specified.

Duty	Engine	Gearbox	Steering unit	Hydraulics
Oil flow	95 litres/min (21 gal/min)	18 litres/min (4 gal/min)	23 litres/min (5 gal/min)	127 litres/min (27·8 gal/min)
Heat dissipation	554 kcal/min (2200 btu/min)	522 kcal/min (1000 btu/min)	265 kcal/min (1050 btu/min)	181 kcal/min (720 btu/min)
Max oil temp	121°C	129°C	157°C	121°C

Header and expansion tank

The tank illustrated is manufactured from 16 swg (1·63 mm) mild steel to British Military Vehicle Engineering Establishment Specification 1131 with the added protection of submersion in a hot solder bath before the application of paint.

When fitted in the vehicle, the engine cooling system is filled through the header tank, then sealed. Under operating conditions the coolant expands with temperature rise into the expansion tank. Maximum pressure in the system is controlled by the fitting of a relief valve at the expansion tank. On engine cooling, the coolant displaced during temperature rise flows back into the cooling system.

Volute casing

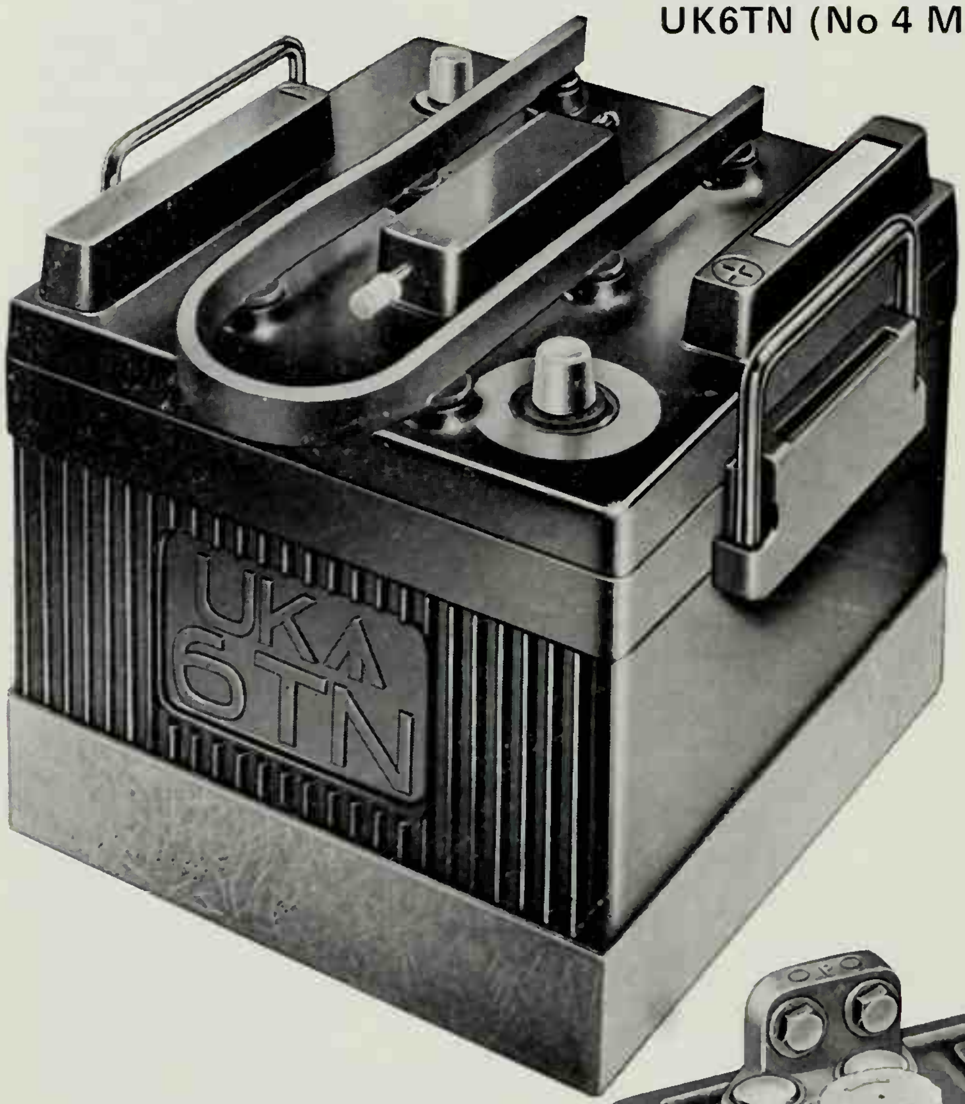
The volute casing and integral inlet duct are formed from 18 swg (1·22 mm) mild steel which is hot-solder-dipped after fabrication. The fabrication is mounted to the engine fan-drive gearbox by a studded anular flange, and seals at the mouth to the radiator case. A fan draws air from the engine compartment and discharges it through the radiator. Wound around the fan inlet duct, the volute expands both radially and axially, finally fairing into the radiator case. This design enables the high-performance backward-curved aerofoil centrifugal fans to be used effectively in the confined available space, with a large percentage of the total fan pressure rise across the radiator.

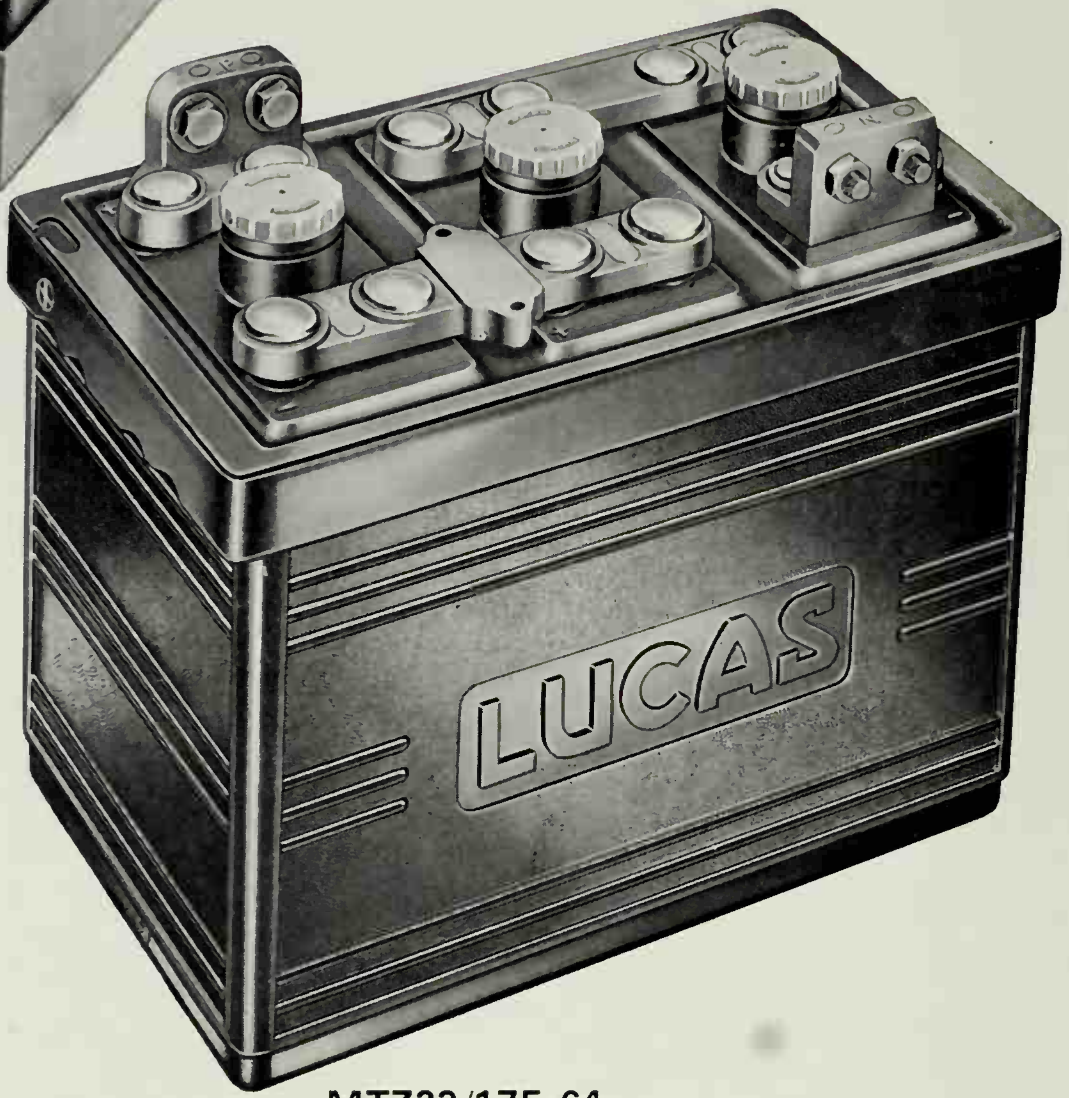
Fan features

Type: HEBA
Diameter: 229 mm (9 in)
Speed: 8400 rev/min
Air flow: 133 m^3/min (4700 ft^3/min) 2 units
Air pressure rise: 386 mm (15·2 in) water gauge

GALLAY LIMITED
Denington Industrial Estate, London Road, Wellingborough, Northamptonshire, NN8 2QU, England
Telephone: Wellingborough 4801

UK6TN (No 4 Mk 3)





MTZ23/17E-64

Storage batteries

Lucas lead-acid type

UK6TN (No 4 Mk 3)

UK6TN (No 4 Mk 3) battery FV 546133
Lead-acid—dry charged
12V 100A—20h rate; (88A—10h rate)
Manufactured to FVRDE specification FV2067
Joint Service Catalogue No 6140-99-803-4364
Overall length 286mm (11$\frac{1}{4}$in)
width 267mm (10$\frac{1}{2}$in)
height 229mm (9in)
Hard rubber container
Central venting system with piped outlet
Raised projections on lid to facilitate stacking
Fully submersible
Glass fibre shoe to resist shock and abrasion
Weight when filled and charged 36·3kg (80lb)
Watts/h/kg at 20h rate 32·8 (W/h/lb 14·9)
Watts/h/kg at 10h rate 28·8 (W/h/lb 13·1)
Can be supplied with topping-up kit FV 546164 (No 1 Mk 1)

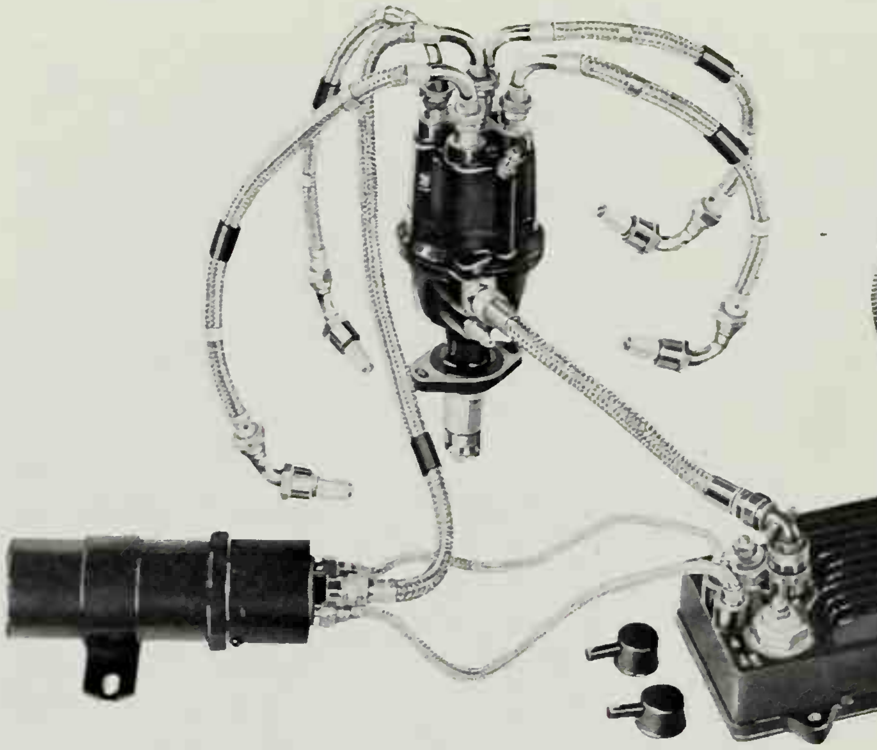
MTZ23/17E-64

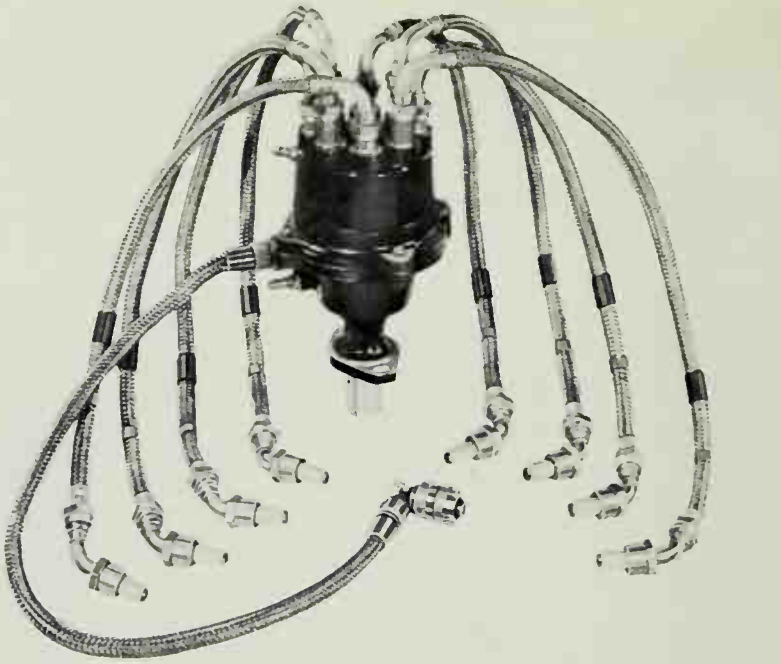
Lucas MTZ23/17E-64 portable secondary lead-acid battery—dry charged
6V 130A—20h rate; (115A—10h rate)
Conforms to MOD Defence Specification DEF18 (FVRDE)
Suitable Joint Service Catalogue No 6140-99-910-1520
Overall length 290mm (11$\frac{7}{16}$in)
width 171mm (6$\frac{3}{4}$in)
height 238mm (9$\frac{3}{8}$in)
Hard rubber container
Porcelain vent plugs
Weight when filled and charged 24·5kg (54lb) approximately
Watts/h/kg at 20h rate 31·9 (W/h/lb 14·5)
Watts/h/kg at 10h rate 28·2 (W/h/lb 12·8)
Can be supplied complete with hold-down device to FVRDE number FV.628037N

JOSEPH LUCAS (BATTERIES) LTD
Commercial Department
Formans Road, Birmingham 11, England
Telephone: 021-777 3292 Cables: Lucasbatt Birmingham Telex: 33105

1966
1967
1969

Lucas OPUS (oscillating pick-up system) ignition





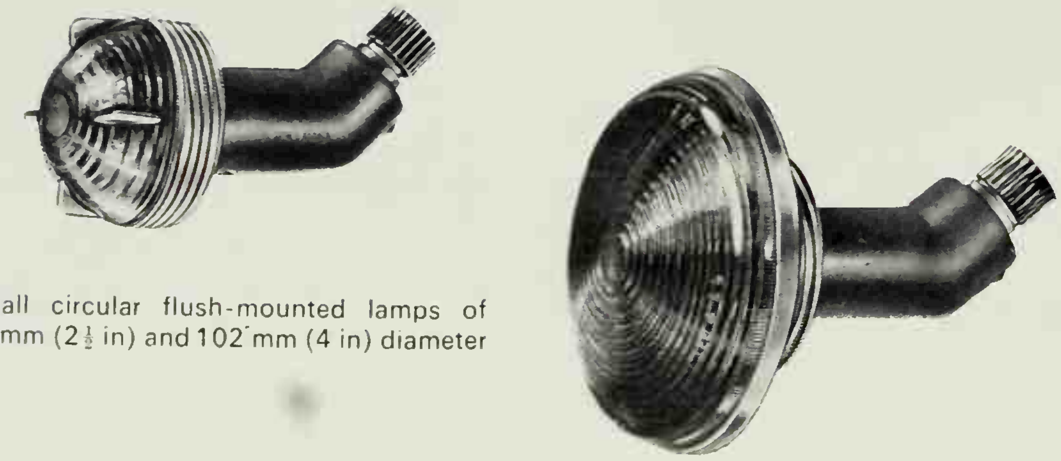
Lucas distributor with shielding to prevent radio interference

Headlamp of 178 mm (7 in) diameter

Headlamp of 114 mm (4½ in) diameter

Commander's spotlamp

Three moulded plastics reflectors in one housing



Small circular flush-mounted lamps of 64 mm (2½ in) and 102 mm (4 in) diameter

Reflector of 102 mm (4 in) diameter

Electrical equipment

for vehicles: ignition and lighting

Joseph Lucas (Electrical) Ltd is a supplier of automotive equipment to the British Ministry of Defence and a range of equipment has been designed and developed specifically to meet the required environmental conditions of the modern British fighting vehicle. A full range of Lucas standard electrical equipment suitable for fitting to general service vehicles and motor cycles is also available, including cable harnesses tailored to meet all kinds of vehicle requirements.

Ignition

Oscillating Pick-up System (OPUS)

This is a fully screened and suppressed contactless ignition system which has been designed for two-, four- and eight-cylinder engines. A six-cylinder system could be made available if required.

The distributor incorporates the well-proven auto-advance mechanism and, in place of the conventional contacts, an electronic pick-up which requires no servicing. Pick-up signals are fed to an amplifier which switches the current in a coil so producing the ignition pulse. The high-tension voltage is distributed in the normal manner. All leads are fitted with inductive resistors to suppress radiated interference and suppression components are built into the amplifier to minimise line-borne interference.

The main advantages in this system are that servicing intervals are greatly extended, greater coil energy is provided, high-speed performance is consistently improved, reliability is increased, the equipment can be fully waterproofed and it is completely shockproof.

Designed and patented by Lucas, this system is an additional development to suit the special requirements of military vehicles.

Ignition distributors

A range of four-, six- and eight-cylinder conventional distributors is available specially developed to suit the specific requirements of armoured fighting vehicles.

These distributors are fully screened against extraneous radio interference, also tested and proved to withstand shock and vibration. They are completely dustproof and waterproof and finished to resist the corrosive action of the elements.

Lighting

The following lamps have been designed and developed by Lucas in conjunction with the British Ministry of Defence to meet all the environmental conditions demanded by modern fighting vehicles. They are manufactured to the British Military Vehicles and Engineering Establishment specification to resist water, dust, shock and vibration, corrosion and extreme temperature conditions.

No 2 Mk 1 FV 157970

A 178 mm (7 in) diameter headlamp with patterned lens, conventional light unit and bulb. Stem fixing by nut and bolt the whole lamp is finished in green. 12 V and 24 V.

Headlamp

designed by Lucas, with full approval of the British Ministry of Defence specifically for the Chieftain tank. A 114 mm ($4\frac{1}{2}$ in) diameter, all-glass sealed-beam light unit encased in a strong lamp shell with stem fixing. Double-filament (main and dipped beam), 125 W and 24 V rating. Available as clear lens No 3 Mk 1 FV604002 and as infra-red No 2 Mk 1 FV494530.

Commander's spotlamp No 1 Mk 1 FV157932

This is a hand-operated lamp on a swivel bracket, complete with on/off switch in the rear of the lamp casing.

Small circular flush-mounted lamps

of strong construction are available as follows:

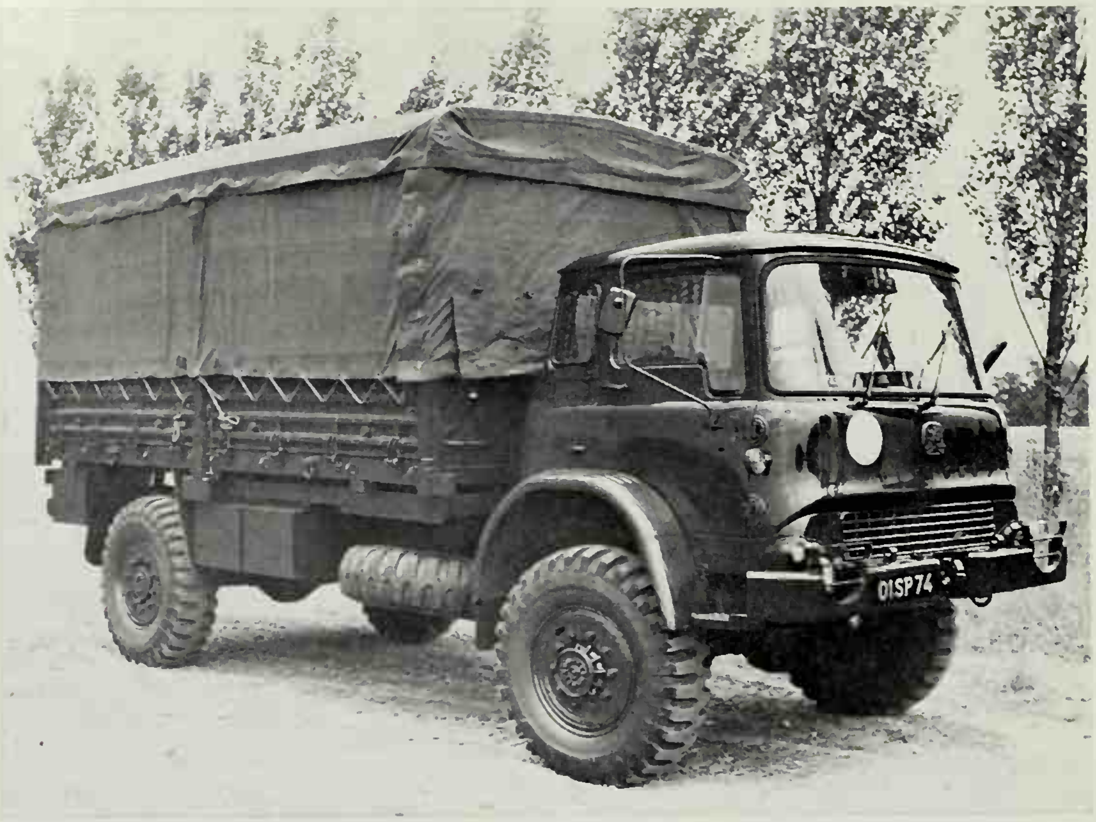
No 3 Mk 1, 64 mm ($2\frac{1}{2}$ in) diameter
  Side FV 260872 clear
  Turn FV 260907 amber
  Stop/tail FV 260673 red
No 3 Mk 2 102 mm (4 in) diameter
  Side FV 260905 clear
  Turn FV 260908 amber
  Stop/tail FV 260906 red

Lucas reflex reflectors

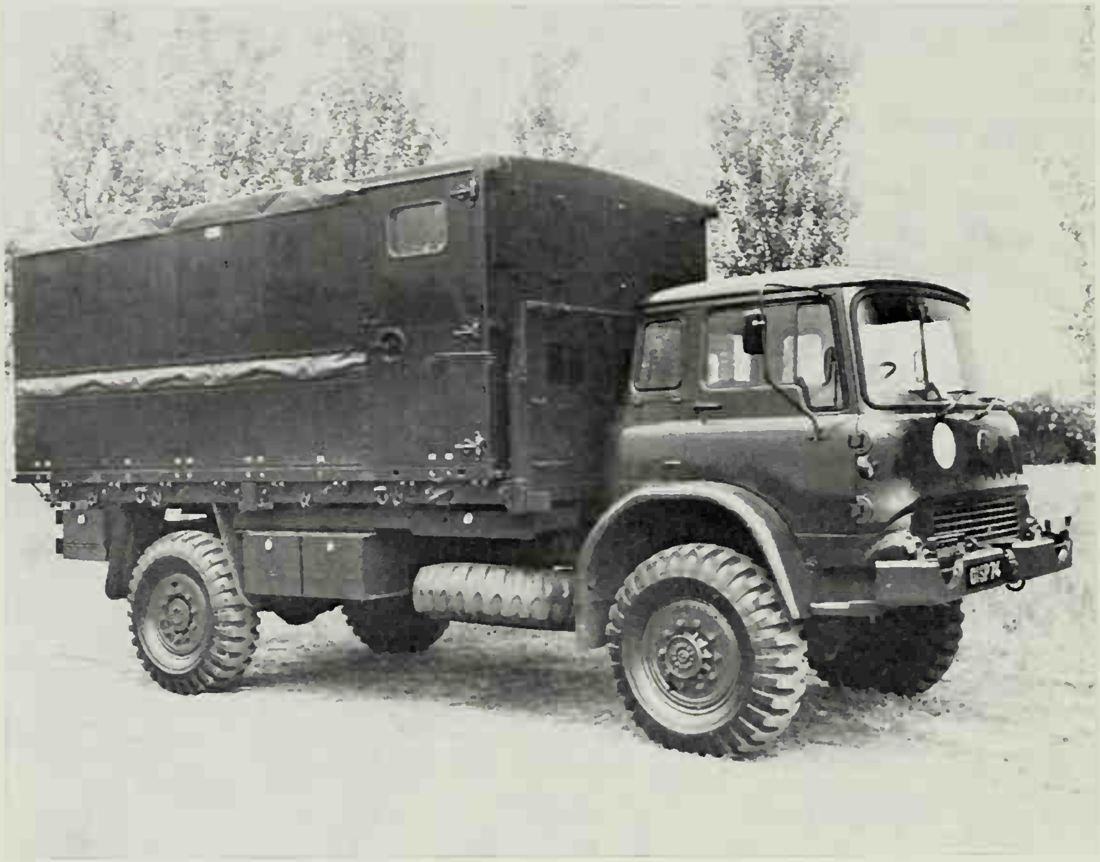
are optically moulded in diakon which is impervious to petrol, oil and is unaffected by temperature change. They are mounted in hard rubber housings and offered for military vehicle use in two designs.

No 1 Mk 1, 114 mm ($4\frac{1}{2}$ in) diameter housing one reflex of 76 mm (3 in) diameter
  FV(s) 21/1/1 red
  FV(s) 21/2/1 amber
  FV(s) 21/3/1 clear
No 3 Mk 1, 143 × 52 mm ($5\frac{5}{8} \times 2\frac{1}{16}$ in) housing three reflexes
  FV(s) 21/5/1 red
  FV(s) 21/6/1 amber

JOSEPH LUCAS (ELECTRICAL) LIMITED
Contract Department
Great King Street, Birmingham 19, England
Telephone: 021-554 5252 Cables: Lucas Birmingham Telex Telex: 338681



The new 4-ton dropside cargo truck body, now being taken into general service as a replacement for the 3-ton body, has been designed and developed in conjunction with the British Military Vehicles and Engineering Establishment to meet the special requirements of the British Ministry of Defence for a general-purpose logistic vehicle with the widest possible applications, including carriage of personnel, bulk cargo, palletised loads, bridging components and special items. The body is of the open type with a detachable, easily erected superstructure and a tailored, waterproof tilt cover. Dropsides and tailboard are of a pressed ribbed section. Dropsides and tailboard may be lowered and the dropsides secured. They may also be removed to provide a flat platform for transportable containers or bulky objects. Heavy-duty cargo lashing rings are spaced along the mainsides. New rotatable flush lashing rings are fitted into the floor. Detachable outward-facing seats are provided for troop carrying. There are many easily accessible lockers for tools and equipment.



The transportable 3-ton truck-mounting container is an insulated, detachable type of body, which combines lightness with great strength and rigidity, and with a service life considerably in excess of bodies of conventional construction. It is designed to provide the maximum utilisation for all branches of the armed forces, and for operation in both mobile and static roles, either mounted on a vehicle or lowered to the ground. It can be used for the carriage of specialist signal and electronic equipment, for installation as a specialised repair vehicle and for fitting out as an office or command post, whenever a controlled, dust-free, weatherproofed environment is required. The container is normally transported on a flat-platform vehicle and there are facilities to enable it to be readily loaded into aircraft, moved from vehicle to vehicle, or lowered to the ground. The wide range of handling equipment considerably extends its usefulness and operational flexibility.

Vehicle bodies and installations made by Marshall of Cambridge (Engineering) Ltd for the British and overseas Governments include:

Ambulances: 2 and 4-stretcher bodies for ¾-ton 4 × 4 chassis

Cargo bodies: 3-ton and 10-ton capacity for 3-ton 4 × 4 and 10-ton 6 × 6 chassis

Office bodies: for 3-ton 4 × 4 chassis and 2-ton 4-wheeled trailers

Radio bodies: for radio installations on 1-ton and 3-ton 4 × 4 chassis

Recovery bodies: providing full recovery facilities for all vehicles up to 3-ton capacity

Special forces vehicles: specialist bodies for light ¾-ton 4 × 4 chassis for use by deep-penetration units

Stores bodies: ordnance 'binned stores' units, for 3-ton vehicles and 2-ton 4-wheeled trailers

Tractor bodies: providing full crew, ammunition and stores accommodation for medium artillery

Workshops: vehicle and trailer-mounted units, providing full repair facilities for motor transport and all general requirements

Buses: bus bodies for use by all services

Vehicle bodies

for military and civil applications

Marshall of Cambridge (Engineering) Limited has been continuously associated with the design and manufacture of military logistic vehicle bodies and body installations for over 30 years and is now an acknowledged leader in this field.

The company has three divisions in one works on Cambridge Airport, which is owned and operated by the company, and has facilities and runways capable of handling any type of aircraft, civil and military, in service to-day or projected for the future.

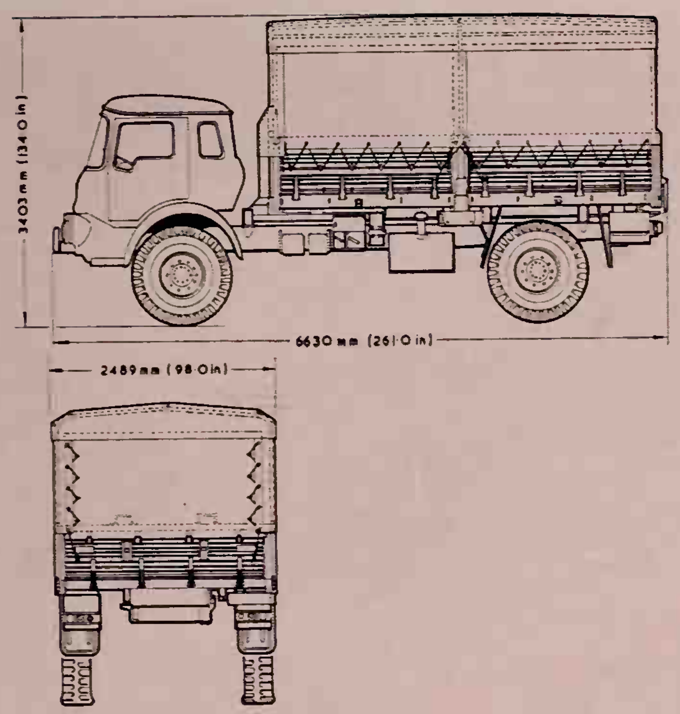
The Aircraft Division undertakes the repair, maintenance, modification or conversion of any type of aircraft and has the finest specialist painting facility in Europe, particularly for polyurethane paint. It is the only officially approved Lockheed C-130 aircraft maintenance and service centre outside North America, designated by the British Government as technical centre for RAF C-130K Hercules aircraft and appointed Grumman 'Gulfstream' spares and service centre for the UK and Europe. The Division is also playing an important part in the Anglo-French Concorde project. All these facilities are supported by large and well-appointed design and technical publications offices and the whole is AQD and ARB approved.

The Omnibus Division, which is completely self-contained, designs and manufactures bodies for transport authorities within the UK and overseas. The Division is noted for its original design work and high standard of product.

The Motor Bodies Division is one of the largest manufacturers of vehicle bodies in the UK. It comprises spacious assembly and finishing shops with all ancillary manufacturing departments, and includes one of the largest specialist phosphating treatment plants in the country. Production embraces bodies and body installations for private as well as military and government vehicles. The design and stress office can carry out original design investigations for prototype manufacture preparatory to full production.

Marshall bodies are continually selected by the British Ministry of Defence, nationalised industries and an ever growing number of overseas governments for their defence forces.

4-ton dropside cargo truck body

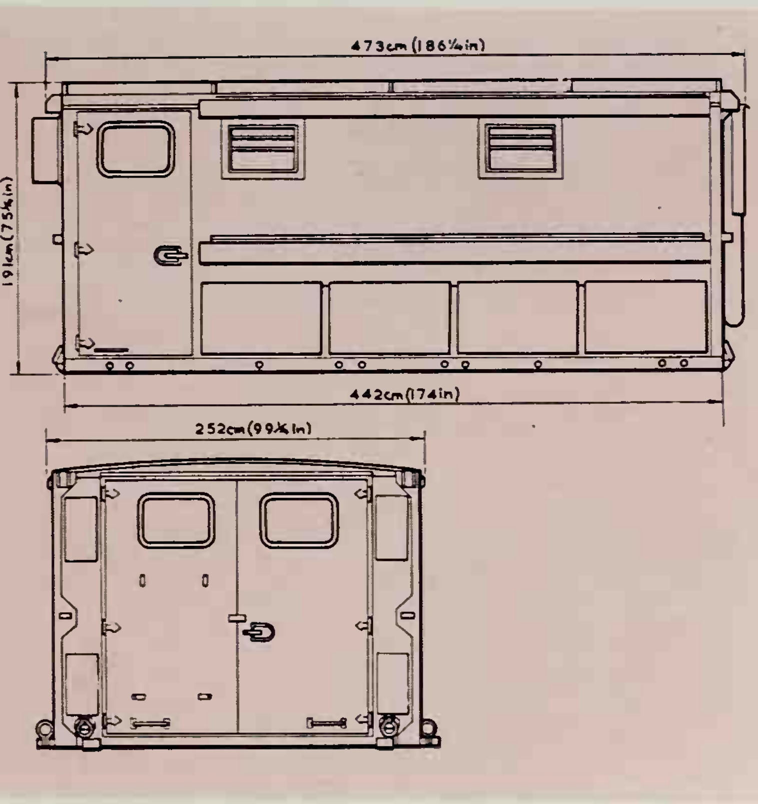


Interior dimensions
Length: 4280 mm (168·5 in)
Width: 2010 mm (90·5 in)
Centre height: 1840 mm (72·5 in)

Weight
Unladen: 5910 kg (12 992 lb)
Laden: 9470 kg (20 832 lb)

The body itself is of steel unit construction, riveted and welded together. The floor is of 2·54cm (1in) thick hardwood firmly secured to the underframe, and all joints are covered with mild steel section wearing strips. All woodwork and the material of the tilt cover is tropic-proofed to provide the fullest possible protection against adverse climatic conditions, and all metal parts are phosphate-dipped to provide long-life protection against corrosion. This complete protection coupled with the rugged method of construction employed results in a good-looking, versatile and proven body at an extremely economic price.

3-ton transportable truck-mounting container type CB 305

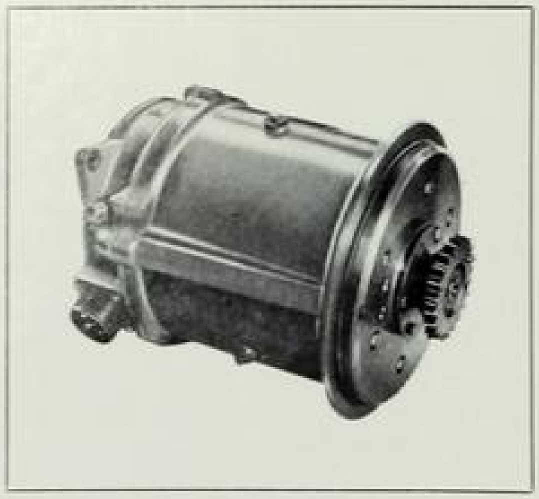


Interior dimensions
Length: 4310 mm (169·68 in)
Width: 2323 mm (91·44 in)
Centre height: 1782 mm (70·32 in)

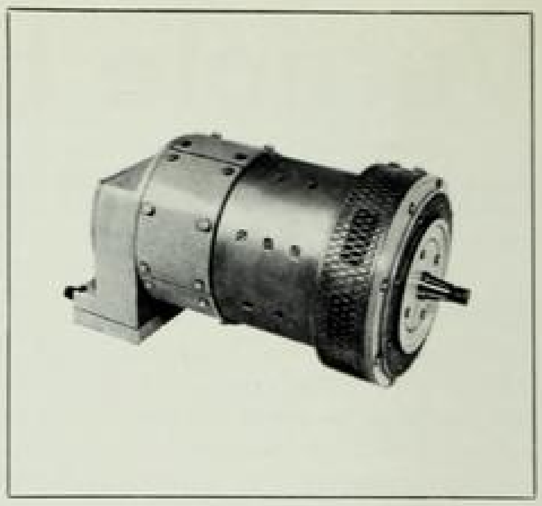
Weight
Unladen: 925 kg (2100 lb)
Laden: 4000 kg (8820 lb)

Modular construction to a very high standard of dimensional accuracy facilitates sealing against the weather and permits the choice of door and window location in any of five positions along each side. Mounting rails secured to the inside walls at three heights and accurately positioned from the floor greatly simplify the installation of equipment, while recessed ducting is provided for internal wiring. Air-conditioning equipment is readily installed using the standard apertures provided, and the whole container can be sealed and pressurised for protection against NBC contamination.

MARSHALL OF CAMBRIDGE (ENGINEERING) LTD
Airport Works, Cambridge, CB5 8RX, England
Telephone: Cambridge 56291 Cables: Marfly Cambridge Telex: 81208

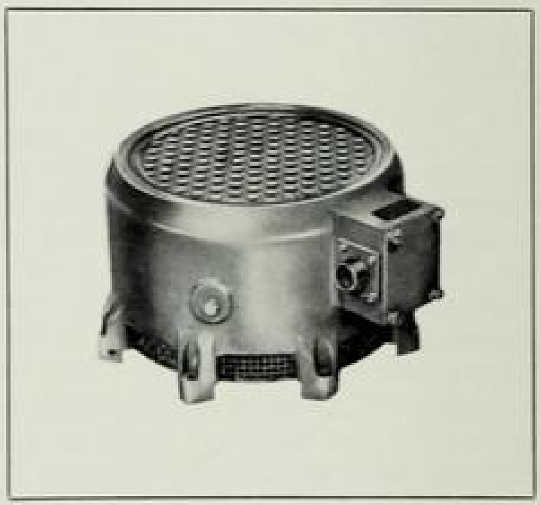


AC generator
Type BA 2803



DC generator
Type B 4901

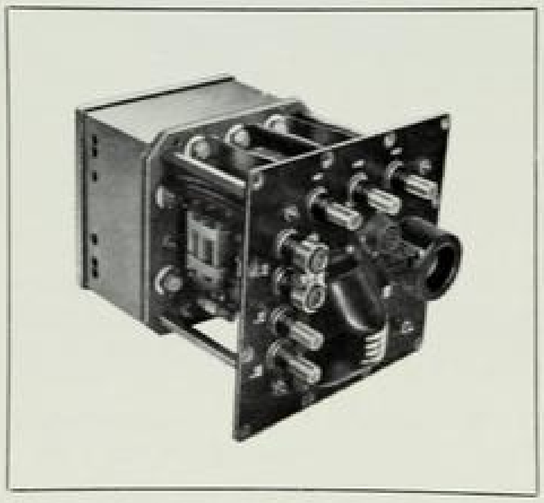
Voltage regulator
Type U 6107



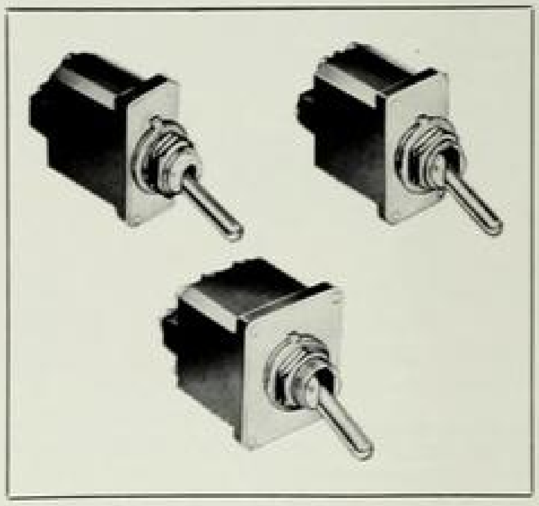
AC generator
Type BA 2202

Power tools transformer
Type U 9102

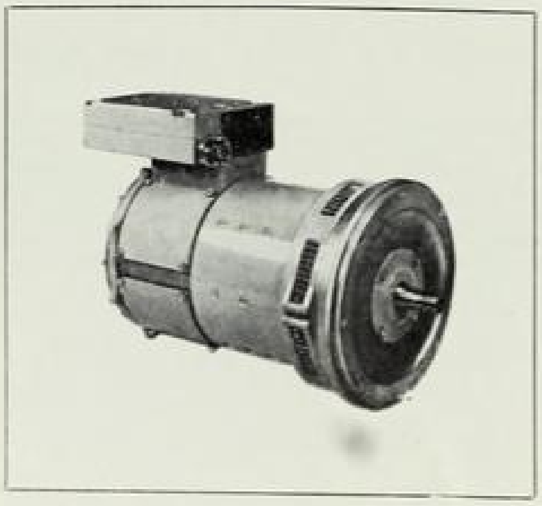
Main engine panel
including voltage
regulator Type U 6606



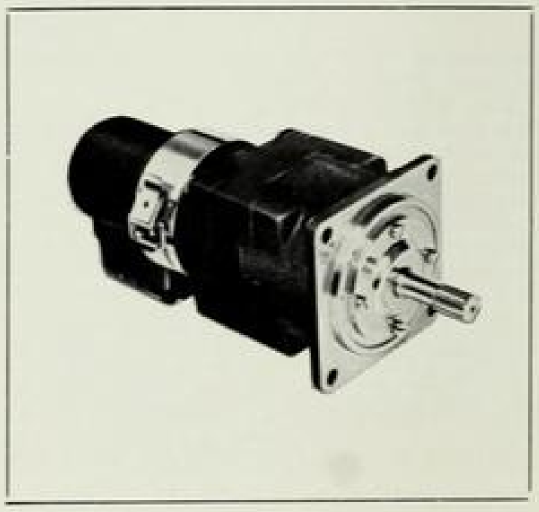
Rectifier
Type ZA 13301



Sealed toggle switches
Series D 13000, D 13500
D 13600



DC generator
Type B3802



Rotary actuator
Type C 5218/2

Electrical equipment

Lightweight generating and starting systems

The Rotax range of mass-produced equipment is designed specifically to meet the severe environmental conditions found in the modern armoured fighting vehicles. The combination of strength and light weight of the equipment, together with a high service reliability, have been fully tested and approved to military standards. The proof of this is shown by the selection of the Rotax wide speed range of the generating and starting systems for the Chieftain tanks.

Specifications

AC generator Type BA 2803

Main output: 3·5 kVA, 0·95 power factor, 25 V, line, 3-phase (rectified output over speed range 1800–12 000 rev/min, 28·5 V dc, 100 A)
Output at power tool transformer: 12 kVA, 0·8 power factor, 3-phase, 208 V, line, 400 Hz at 8000 rev/min
Solid rotor (brushless)
Oil-cooled (122°C oil inlet max)
Acceleration: 15 000 rev/min per second max
Reversible
Military specification
Weight: 31·18 kg (68·75 lb)
Overall length: 305 mm (12·00 in)
Overall diameter: 244 mm (9·61 in)
Environment-free, submersible
Ambient temperature: –40°C to + 85°C

Voltage regulator Type U 6107

28·5 V dc ± 2% over whole load, speed and temperature range
Silicon-controlled rectifier type
Military specification, waterproofed
Weight: 4 kg (9 lb)
For use with above generator, incorporating
Field current limiting
Field overheat protection
Battery temperature compensation
Load sharing 3 (from separate transformers P 15202)
Ambient temperature: –40°C +85°C

Power tools transformer U 9102

208 V 11·7 kVA, 400 Hz, 3-phase (generator at 8000 rev/min) or:
208 V, 8·3 kVA, 400 Hz, 3-phase plus 28·5 V dc, 100 A, via rectifier ZA 13301
Step-up auto transformer
Military specification
For use with above generator
Weight: 19 kg (42 lb)

Rectifier Type ZA 13301

28·5 V, 200 A dc output 3-phase, full-wave bridge, static rectifiers
Military specification
Weight: 14 kg (30½ lb)
22 V, 165 A ac, 3-phase input from 90 to 600 Hz
Oil-cooled (122°C oil inlet max)
Silicon diodes
For use with two of the above generators

DC generator Type B 3802

Output: 28·5 V, 350 A
Cutting-in speed: 3000 rev/min
Full-load speed range: 3800–4200 rev/min
Military specification
Air-cooled (internal fan)
Weight: approx 47·6 kg (105 lb)
Overall length: approx 375 mm (14·76 in)
Overall diameter: approx 254 mm (10·00 in)

DC generator Type B 4901

Output: 28·5 V, 150 A
Speed: 3300–8400 rev/min
Military specification
Air-cooled (internal fan)
Weight: approx 41 kg (90 lb)
Overall length: approx 428 mm (16·85 in)
Overall diameter: approx 228 mm (8·97 in)

AC generator Type BA 2202

Output: 395 V, 9 A ac
Full-load speed range: 3800–4200 rev/min
Weight: 12·2 kg (27 lb)
This ac generator is available for building-on to the dc generator B 3802 for battery heating purposes

Main engine panel, including voltage regulator Type U 6606

Weight: 22·7 kg (50 lb)
For use with dc generator B 3802

Sealed toggle switches

Current rating:
at 28 V dc: 15 A (resistive), 10 A (inductive)
at 200 V ac: 10 A (0·75 power factor lag)
Contacts: hard silver
Switch action: double break, quick make-and-break, self-aligning, wipe action; lever action provides force to break contact tack welding
Lever positions: numerous combinations of contact connections covered in the switch ranges
Spring-return facilities and lever locking in any position
Switch ranges:
Single-pole D 13000 Series
Double-pole D 13500 Series
Three-pole D 13600 Series
Four-pole D 16500 Series

Rotary actuator C 5218/2

This actuator is used for opening and closing a heavy armoured door on the Chieftain tank
28 V dc operation 33·9 Nm–170 Nm (25 lb ft–125 lb ft) load rating
Actuators to cover the following ranges are also available:

Rotary actuators

28 V dc operation 1·13 Nm–135·6 Nm (10 lb in–100 lb ft) load rating
112 V dc operation 142·4 Nm–285 Nm (105 lb ft–210 lb ft) load rating
26 V ac operation 1·7 Nm–6·8 Nm (15 lb in–60 lb in) load rating
115 V ac operation 0·56 Nm–11·3 Nm (5 lb in–100 lb in) load rating

Linear actuators

28 V dc operation 2·27–4763 kg (5–10 500 lb) load rating
112 V dc operation 72·6–13 608 kg (1600–30 000 lb) load rating
122 V ac operation 22·7–91 kg (50–200 lb) load rating

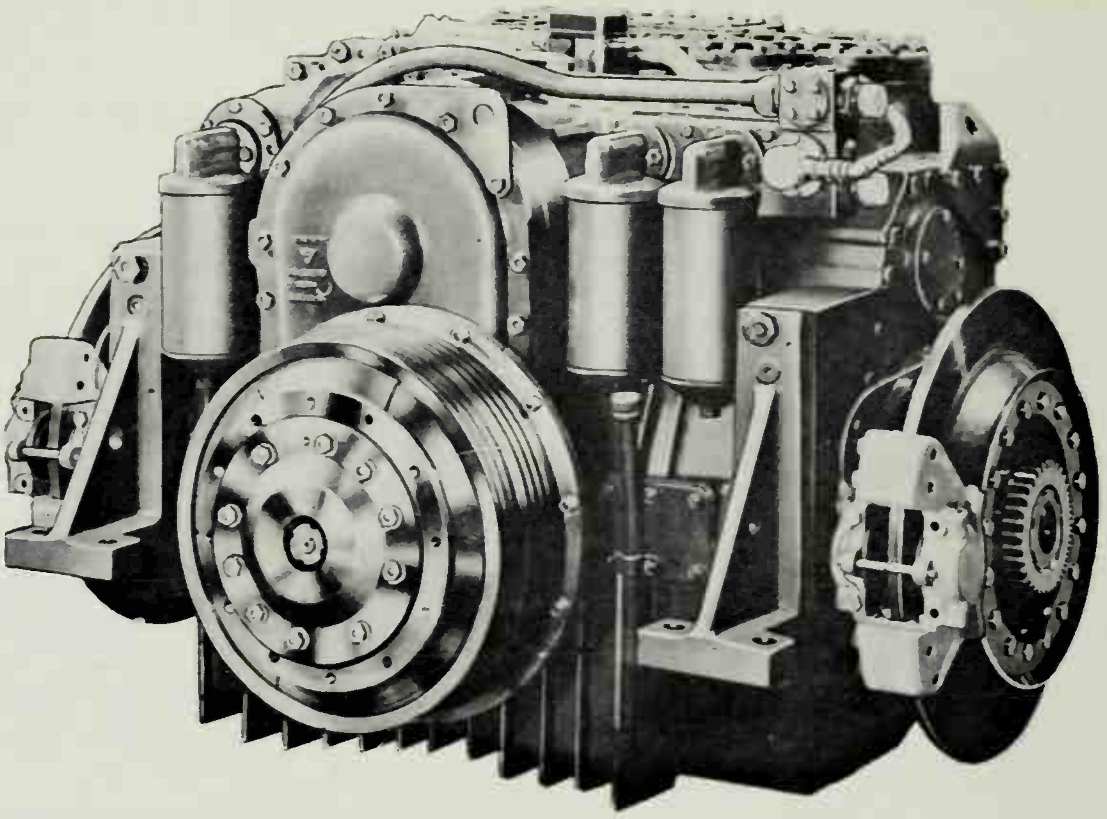
ROTAX LIMITED
Chandos Road, Willesden Junction, London NW10, England
Telephone: 01-965 7777 Cables: Rodynalite London Telex: 23662

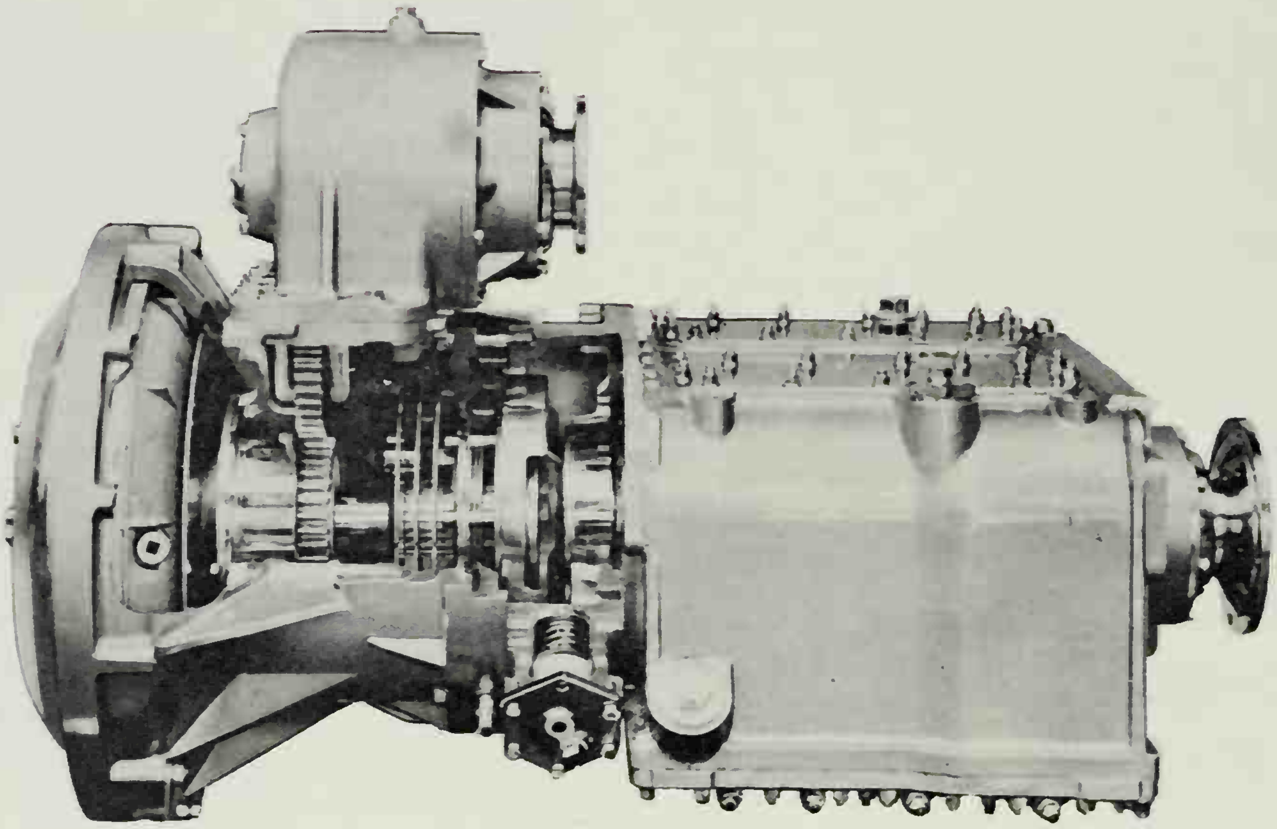
ROTAX

1966
1969

The compact type TN.12 gearbox is used in both the Chieftain heavy and Vickers medium tanks. This unit combines the SCG oil-operated epicyclic gear arrangement with a Merritt steering system and provides six forward and two reverse speed ratios.

Control for the gear change is by a foot-operated electrical solenoid valve. In the event of a complete electrical failure in the control system, a manually operated emergency control is provided to obtain 2nd forward gear or emergency low reverse. Drive from the engine is through a centrifugal clutch incorporated at the gearbox input.





Included in the range of SCG transmissions is the type 357 which comprises a five-speed semi-automatic two-pedal control gearbox with splitter unit giving ten forward speeds. A sectional model is illustrated showing the splitter section, fluid clutch and power take-off.

With no conventional clutch causing a break in power delivery these types of transmissions maintain torque at the vehicle wheels during each gear change, ideal for both hard and soft surface operations.

Gear changes are effortless, and due to elimination of the operation of a heavy clutch and gear lever driver fatigue is greatly reduced under all operating conditions.

In order to provide an auxiliary drive for operation of winches, pumps and other equipment a power take-off can be fitted.

Transmissions

for military vehicles

The compact design of SCG transmissions plus the ability to provide suitable control systems are particularly acceptable to designers of today's military vehicles, the TN.12 gearbox used in both the Chieftain heavy and Vickers medium tanks being typical of the type of unit which has been designed, developed and produced by this company.

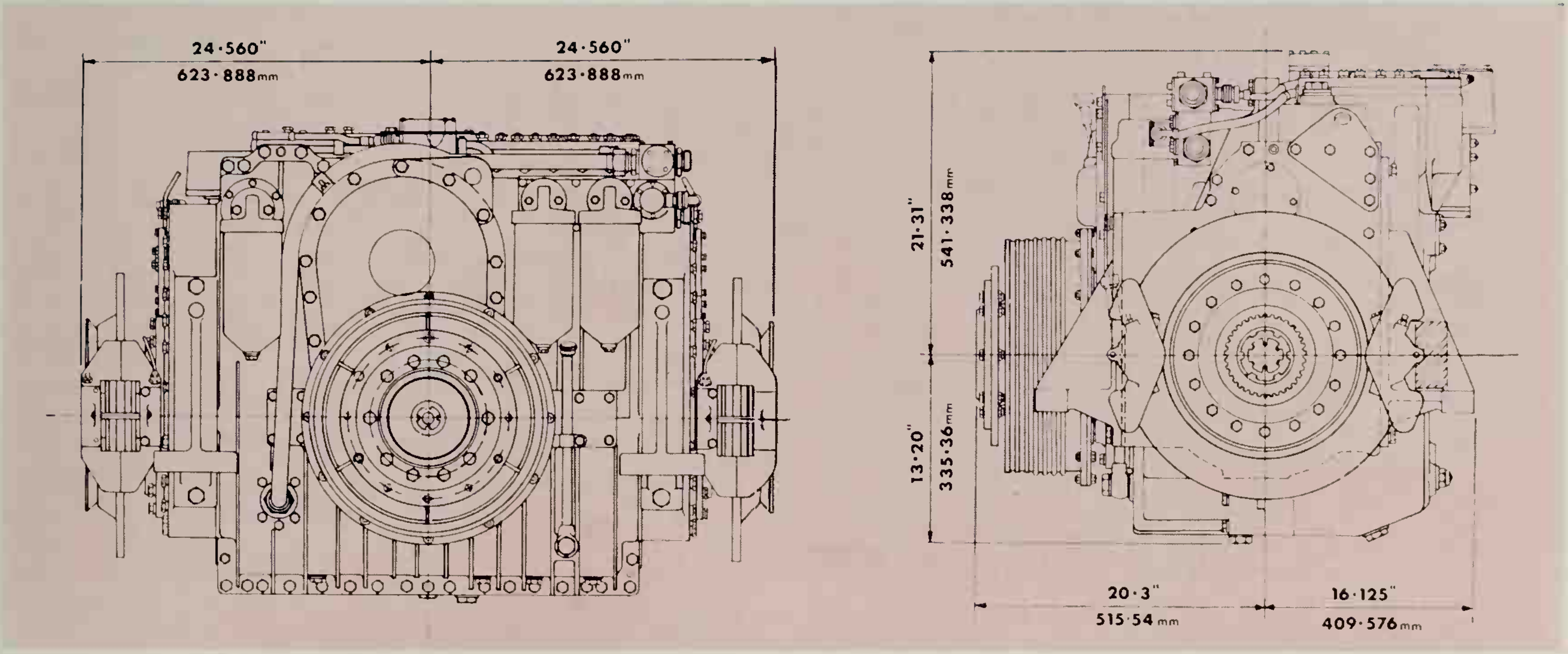
Included in the SCG range of transmissions is the type 357 which comprises an integral semi-automatic five-speed gearbox and splitter unit with either a fluid flywheel or fluid clutch. The splitter section embodies a two-speed unit giving a direct drive and overdrive designed to split the main gearbox ratios, effectively converting the five forward speeds to ten. A four-speed version of this unit is also available.

The basic feature of all SCG automotive transmissions is the compound epicyclic gear arrangement which can be operated either by pneumatic or hydraulic arrangements.

Semi- or fully-automatic in operation, these gearboxes need only an accelerator, a brake and a simply operated gear selector.

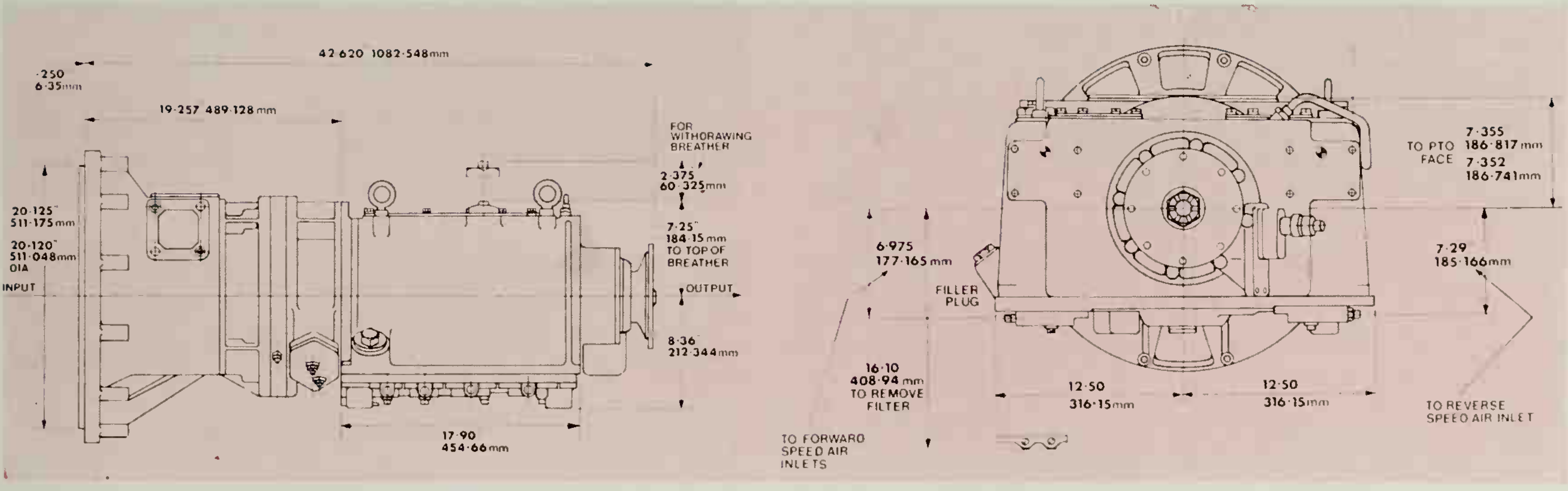
With no conventional clutch causing a break in power delivery SCG transmission maintains torque at the vehicle wheels during each gear-change. Operation on unmade roads and under soft ground conditions is much faster and even on hard roads a significant improvement in vehicle acceleration can be obtained.

The range of SCG transmission systems is extensive and includes standard gearboxes with up to 16 forward speeds, torque converters, fluid clutches and flywheels, two-speed dynamo drives, power take-off arrangements, and heavy-duty marine units.


24·560"
623·888mm
24·560"
623·888mm
21·31"
541·338mm
13·20"
335·36mm
20·3"
515·54mm
16·125"
409·576mm

TYPE TN.12 semi-automatic transmission, six forward and two reverse speeds ratios:

Rev.	9·75:1	1st	14·65:1	3rd	5·22:1	5th	2·24:1	Rev (low)	9·84:1	Weight (dry)	1270 kg (2800 lb)
Rev	6·51:1	2nd	8·45:1	4th	3·34:1	6th	1·52:1	Rev (high)	6·58:1	Maximum torque	221·2 kgm (1600 lb ft) at 1800/2000 rev/min
										Maximum hp	700 at 2670 rev/min


42·620 1082·548mm
·250
6·35mm
19·257 489·128mm
FOR WITHDRAWING BREATHER
2·375
60·325mm
20·125"
511·175mm
20·120"
511·048mm
DIA
INPUT
7·25"
184·15mm
TO TOP OF BREATHER
OUTPUT
8·36"
212·344mm
17·90
454·66mm
6·975
177·165mm
FILLER PLUG
16·10
408·94mm
TO REMOVE FILTER
TO FORWARD SPEED AIR INLETS
12·50
316·15mm
12·50
316·15mm
TO PTO FACE
7·355
186·817mm
7·352
186·741mm
7·29
185·166mm
TO REVERSE SPEED AIR INLET

TYPE 357 semi-automatic transmission, 5/10 forward and 1 reverse speed ratios.

Ratios:		Split ratios:	Ratios:		Split ratios:		
1st	7·25:1	5·58:1	4th	1·59:1	1·225:1	Weight (dry) including splitter	358 kg (790 lb)
2nd	4·28:1	3·29:1	5th	1·00:1	0·77:1	Maximum torque	89·9 kg m (650 lb ft)
3rd	2·43:1	1·87:1	Rev.	5·97:1	4·6:1	Maximum hp	250 (on highway rating)
						Maximum input speed	3500 rev/min
						Power take-off	Optional, air-operated, full torque, 1:1 ratio

SELF-CHANGING GEARS LIMITED
Military Sales Division
Berkeley Square House, Berkeley Square, London W1, England
Telephone: 01-499 6050 Cables: Leymotors London W1 Telex Telex: 22498

BRITISH
LEYLAND

Cooling fans

for the Scorpion and other fighting vehicles

'In the early development work carried out by the British Military Vehicles and Engineering Establishment, a main engine cooling fan was sought which was as quiet and as compact as possible within the limited hp available.

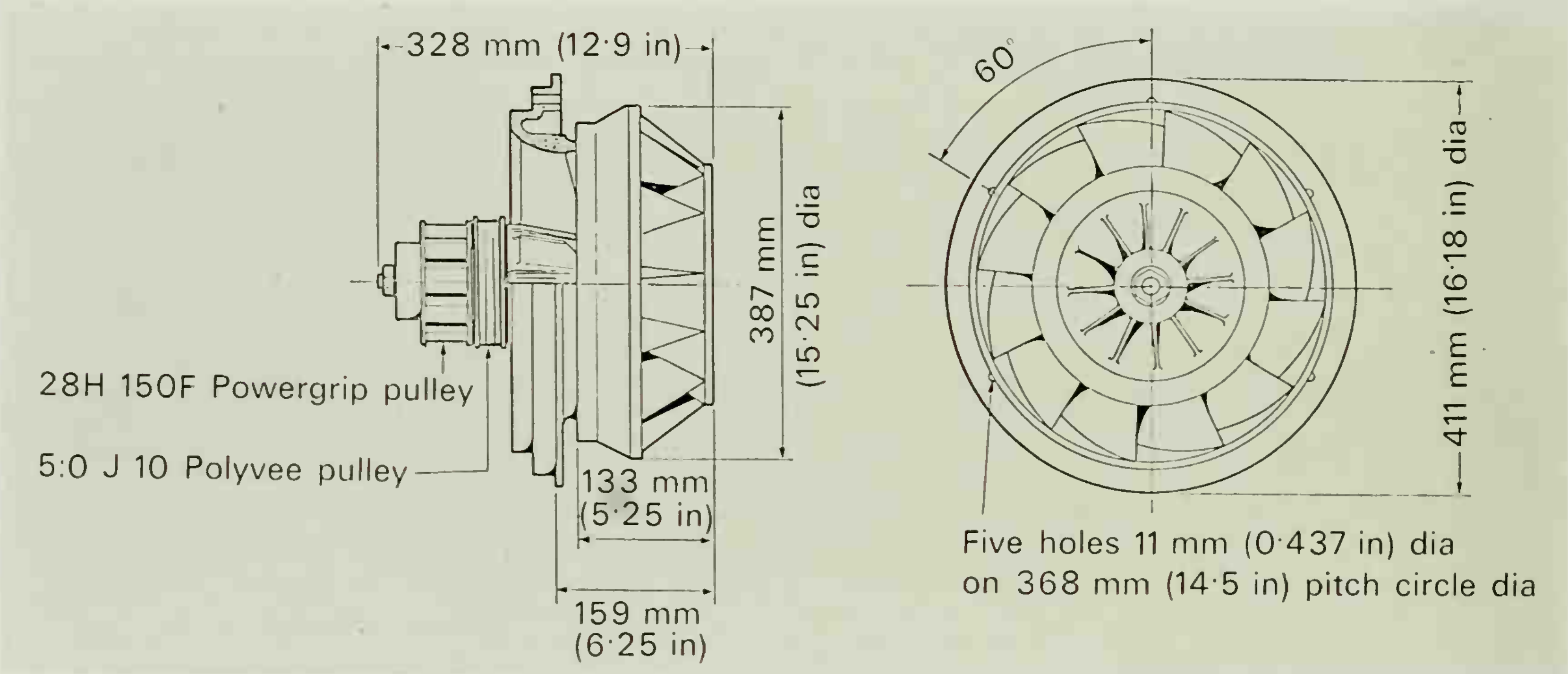
The type chosen is a 304 mm (12 in) mixed-flow fan from the Airscrew-Weyroc Ltd Fan Division range - (a smaller fan than the size originally believed to be necessary) with a rated performance of 170 m^3 (600 ft^3) of air per minute at a fan static pressure of 203 mm (8 in) water gauge.

This fan unit reduced the expected hp by approximately 40 percent and its very low noise is completely masked by the relatively quiet engine and other equipment. The fan, which weighs 20·4 kg (45 lb) incorporates a drive of the toothed belting type which has the advantage of low power loss due to no slip, compactness, and the elimination of the need for tensioning adjustment . . .'

Heating and Ventilating Review (December 1969)

'Another interesting feature of the Scorpion is a novel mixed-flow engine cooling fan developed by Airscrew-Weyroc Ltd. The fan is driven by a wide toothed belt off the engine to transmission shaft and is relatively quiet which makes it particularly suitable for a light tank intended to be used for reconnaissance.'

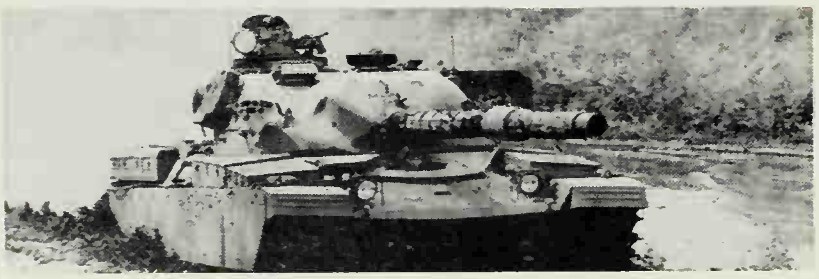
Richard M. Ogorkiewicz, MSc(Eng), MIMechE
Engineering (September 1969)



Specification

Description: 300 mm (12 in) nominal dia belt-driven mixed-flow fan unit designed for use without casing
Rated performance: 170m^3 (6000 ft^3)/min at 203 mm (8 in) water gauge fan static pressure at sea level
Drive: by belt at 6050 rev/min, 16 hp
Weight: 20·4 kg (45 lb)
Approx noise level: 100 dB at 0·9 m (3 ft)
Time rating: continuous
Ambient temperature range: –40°C to +75°C
Climatic rating: DEF 133, Clause 11
Vibration grade: DEF 133, Clause 8
Flame proofness: inherent
Fireproofness: inherent
Waterproofness: DEF 133, Clause 15

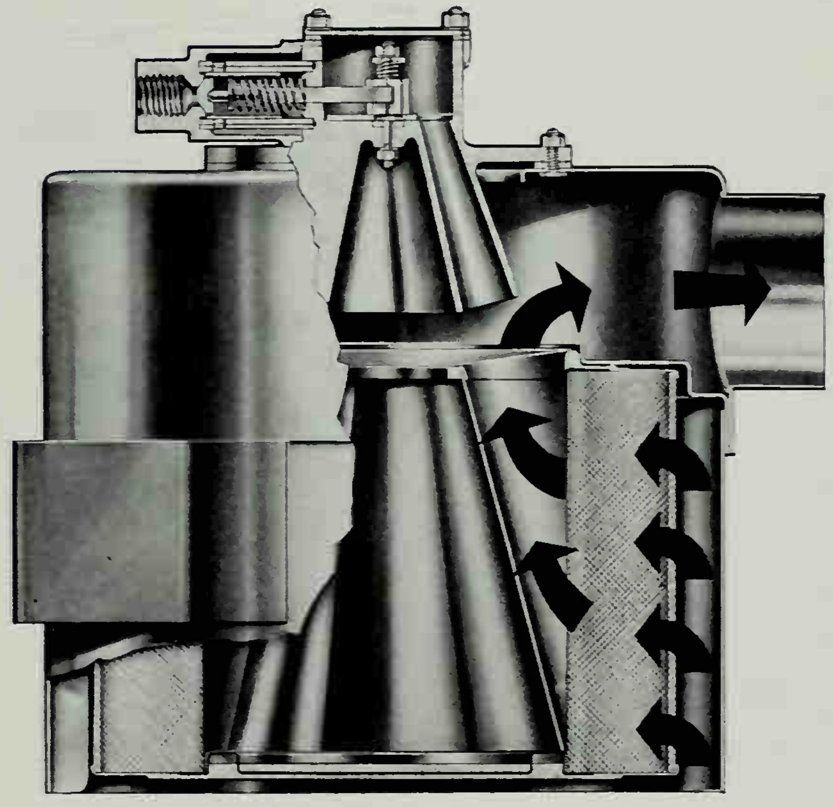
Airscrew-Weyroc fans of various types are also used to cool both the engines and interiors of other famous fighting vehicles including the Chieftain tank and Ferret scout car, and for other purposes such as component cooling, vehicle pressurising and engine air-cleaner scavenging



AIRSCREW-WEYROC LIMITED
Fan Division
Weybridge, Surrey, England
Telephone: Weybridge 45599

Self-cleaning air filters

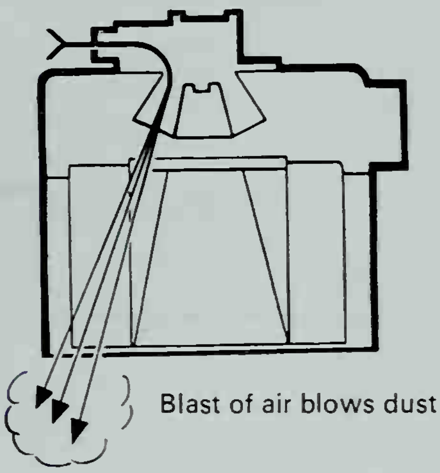
for protecting engines in severe dust conditions



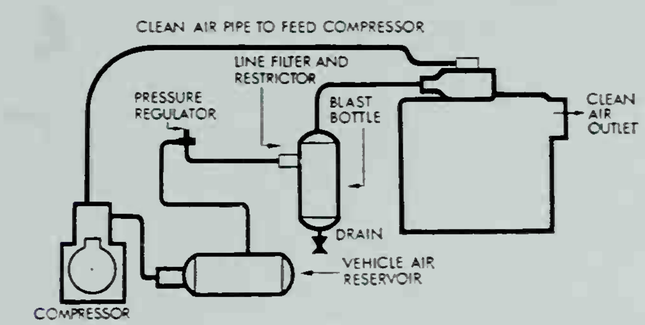
Cooper-King filter system

The Cooper-King self-cleaning air filter system ensures virtually 100 per cent efficiency with minimal servicing. The filter elements in these air cleaners are kept constantly clean so that vehicles and plant to which they are fitted may operate continuously. Designed for the most severe dust conditions, the units clean themselves with blasts of air discharged at the clean side of each of eight segments of the element in turn. It is thus virtually unnecessary for equipment to be inoperative for air cleaner servicing.

The diagrammatic layout shows how the system is arranged. Pressure in the blast bottle is built up to between 5·6 and 6 kgf/cm^2 (80–85 lbf/in^2) from the vehicle's own compressed air source, the build-up rate being controlled by a timing orifice or restrictor. When the maximum pressure is reached a piston moves off a valve seat allowing the air to be rapidly released through a discharge tube into one of the eight element segments. In returning to its seating the piston rotates a valve plate which opens up the next segment for cleaning. The blowing interval, determined by the timing orifice, is preset to suit operational conditions.



Blast of air blows dust back to atmosphere



Diagrammatic layout of the Cooper-King self-cleaning air filter system

COOPERS MECHANICAL JOINTS LTD
Llanfoist Works, Abergavenny, Monmouthshire, Wales
Telephone: Abergavenny 2041

Coopers

Rubber components for fighting vehicles

Specialists in the design and development of rubber products for fighting vehicles, the Avon Rubber Company Limited produces moulded components and rubber-to-metal bondings for track and suspension systems.

Avon also manufactures rubber bushes and bonded pads, bonded solid-rubber tyres for track road wheels, idler wheels and sprocket support wheels, as well as bonding rubber pads direct on to metal track links.

Avon specialises in the development of rubber compounds and components for all armoured fighting vehicles, including the Chieftain battle tank, all designed to meet the most rigorous operational and environmental conditions.

Avon Rubber Co Ltd
Bradford-on-Avon, Wiltshire England
Telephone: Bradford-on-Avon 2191
Cables: Industrial Bradford-on-Avon
Telex: 44856

Tyres

Tyres for all types of wheeled transport to suit operating conditions both at home and overseas are manufactured by Avon. These tyres, by research, development and modern production methods, have been kept in the forefront of design and innovation. They are manufactured for on/off road use covering the whole range of cars, Land Rovers, light commercial vehicles, trucks and passenger transport vehicles, as well as mechanical handling equipment, industrial trucks, low-loader vehicles, agricultural equipment, agricultural implements, special-purpose vehicles and motor cycles. Part of the range of car and truck/bus tyres is especially designed for operation over ice and snow. Avon is one of the largest rubber manufacturing groups in the United Kingdom and is among the leaders in the tyre industry.

Avon Rubber Co Ltd
Melksham, Wiltshire, England
Telephone: Melksham 3101
Cables: Rubber Melksham
Telex: 44142

Aluminium alloy armour plate

Approved supplier of aluminium alloy armour plate (to British Military Vehicle and Engineering Establishment spec 1318), extrusions and castings used on the Scorpions and Fox lightweight armoured reconnaissance vehicles.

The plate can be manufactured to a maximum length of 5·49 m (18 ft), maximum width of 1·83 m (6 ft) and a gauge range from 19 mm (0·75 in) to 76 mm (3 in). Aluminium alloy armour plate can be supplied in the machined and formed condition ready for welding and is suitable for converting existing transport into lightweight armoured vehicles.

The British Aluminium Co Ltd
Norfolk House, St James's Square London SW1, England
Telephone: 01-839 8888
Cables: Britalumin London SW1
Telex: 22756

Vehicle-installed dose rate meter

Designed in collaboration with the British Atomic Weapons Research Establishment, Aldermaston, the NIS 504 Vehicle-Installed Doseratemeter is for installation in military vehicles. It is used to monitor the external gamma doserate and the gamma doserate to the crew. Internal and external probe assemblies are provided, together with a common control and display unit which supplies power to the probes and enables the reading from any one probe to be displayed on the logarithmic scale of a meter (1–1000 rad/h).

The system is powered from the vehicle's 24 V supply system and can provide an external alarm signal if required.

Electronic Associates Ltd
Victoria Road, Burgess Hill, Sussex, England
Telephone: Burgess Hill 5101
Cables: Pace Burgess Hill
Telex 87183

Heat exchangers flexible fuel tanks

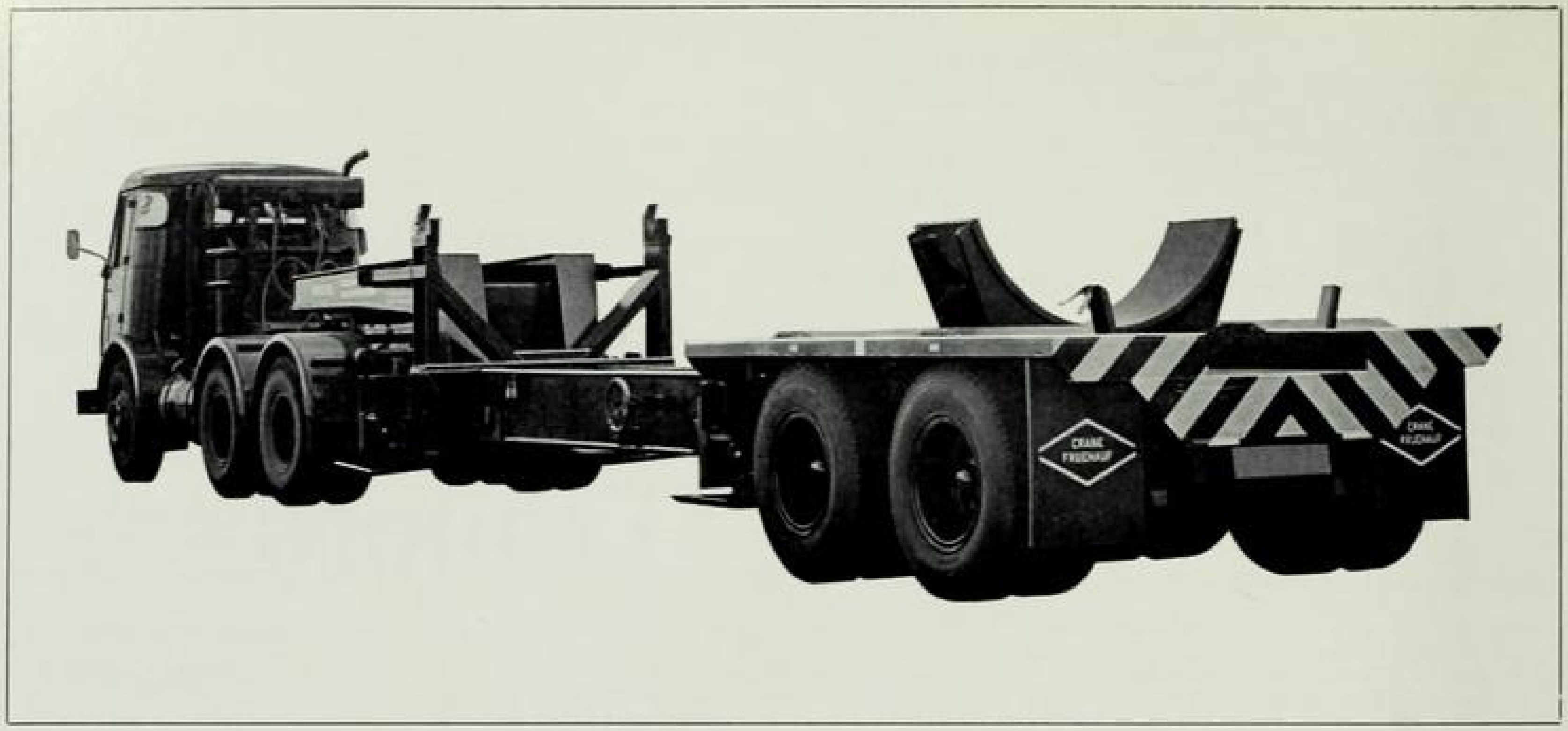
Marston Excelsior has many years of experience in heat transfer and can supply lightweight, compact aluminium alloy heat exchangers for all armoured fighting vehicle applications, including high-pressure rated radiators, air/oil cooler radiators, charge air coolers, oil coolers for gearbox and hydraulic services and heat exchangers for air conditioning, of secondary surface and tubular designs.

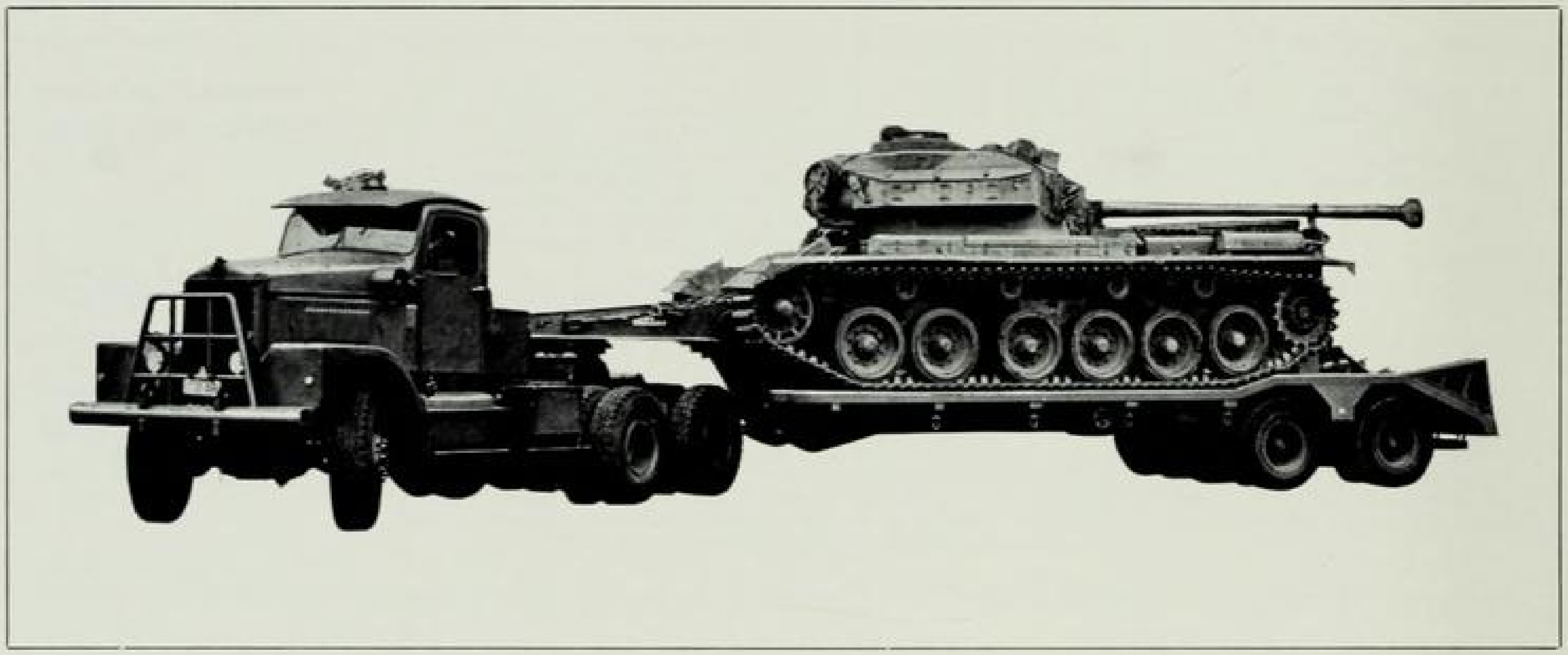
Marston also supplies flexible fuel tanks made from specially developed fabric-reinforced rubber materials which, being flexible, remain reliable in service under the most arduous conditions and are preferred to metal tanks to avoid fuel loss due to fracture from vibration and shock loads. Fire- and explosion-suppression plastics foam can be incorporated.

Marston Excelsior Ltd
Wobaston Rd. Fordhouses, Wolverhampton, Staffs, WV10 6QJ, England
Telephone: Fordhouses 3361
Cables: Marex Wolverhampton Telex
Telex: 33211

Section 15

Trailers


CRANE FRUEHAUF
CRANE FRUEHAUF



CRANE FRUEHAUF
CRANE FRUEHAUF

Semi-trailers

for heavy loads

Crane Fruehauf Trailers Ltd has manufactured large numbers of all these semi-trailer vehicles, and various such units are in service throughout the world. Full specifications are available for individual requirements

The Crane Fruehauf general missile carrier

General dimensions
Frame length 11·45m (37ft 6¾in)
Centre line of rear bogie to centre line of kingpin 9·45m (31ft)
Centre line of rear cradle to centre line of front trunnion support 6·30m (20ft 8¼in)
Centre line of front trunnion support to centre line of kingpin 3·14m (10ft 3⅝in)
Kingpin from front of semi-trailer 457mm (18in)
Centre line of rear support jacks to centre line front support jacks 5·08m (16ft 8in)
Transverse centre lines to jacks 1·73m (5ft 8in)
Centre lines of axles on rear bogies 1·29m (4ft 3in)
Spring centre 1·02m (3ft 4in)
Wheel track 1·82m (5ft 11½in)
Overall width 2·44m (8ft)

This carrier is a basic trailer design which can be adapted for loads up to 30 tons. All materials and finishes are in accordance with British Standards and/or Defence specifications. Frame assembly is of drop-frame construction, comprising two longitudinal members of high-tensile steel box section with suitable cross members, providing minimum weight with maximum strength. Axles are machined from high-tensile steel bar and fitted with taper roller bearing hubs. Each axle is independently sprung with laminated springs and buffer-type shoes giving progressive action. When the carrier is coupled to the towing vehicle, it is capable of turning to an angle of 90 deg to the prime mover.

The Crane Fruehauf 50/60-ton tank transporter semi-trailer

General dimensions
Overall length 11·58m (38ft) approximately
Kingpin centre to centre of rear bogie 8·86m (29ft 1in)
Overall width 3·35m (11ft)
Width of main deck 3·35m (11ft)
Height of main deck 1·15m (3ft 9⅛in) laden
Ground clearance under frame 0·68m (2ft 3in) laden

Weight distribution
Unladen weight of semi-trailer 15 089kg (33 264lb)
Unladen semi-trailer at kingpin 6046kg (13 328lb)
Imposed load at kingpin with 50-ton tank 21 337kg (47 040lb)
Total imposed load at kingpin 27 383kg (60 368lb)
Total unladen weight at ground on rear bogie 9042kg (19 936lb)
Payload at rear bogie with 50-ton tank 29 465kg (64 960lb)
Total imposed load at rear bogie 38 508kg (84 896lb)
Total weight of semi-trailer with 50-ton Centurion tank 65 891kg (145 264lb)

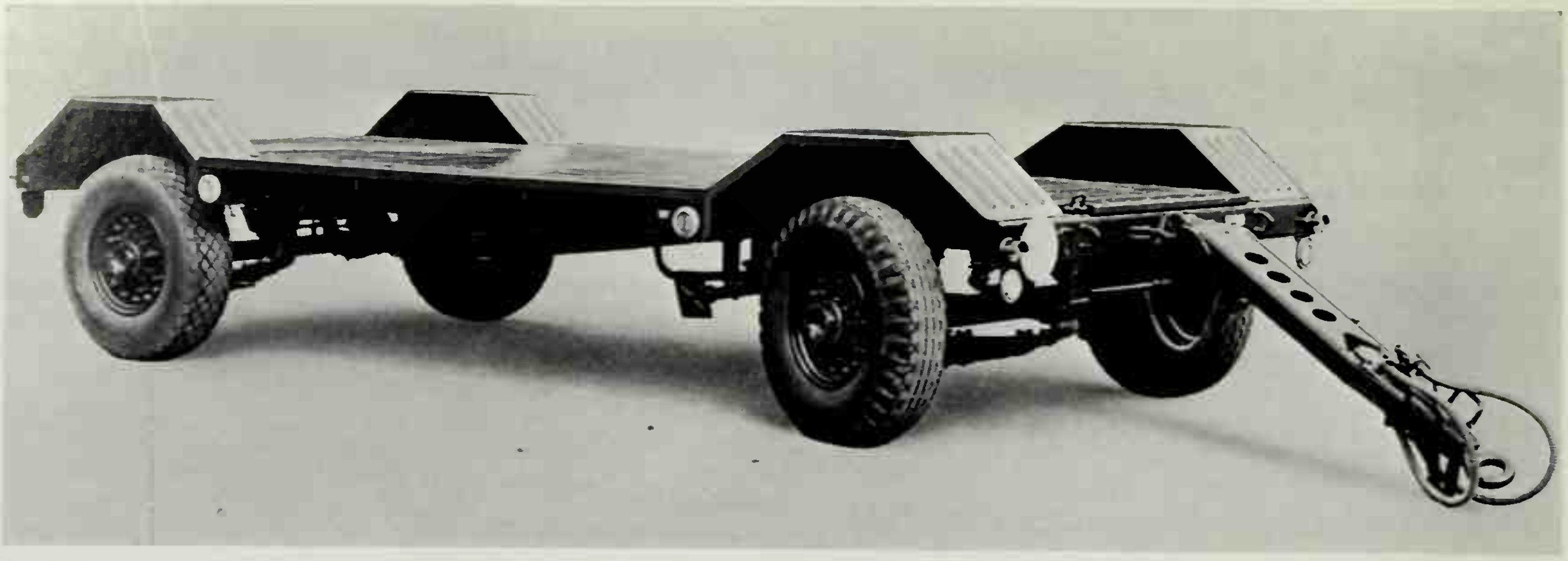
This transporter has been designed to carry the Centurion, Cromwell, Sherman, Charioteer, Vickers and American M47 tanks. Proved in service in the Middle East, the design employs a cranked frame incorporating mild-steel decking welded to and strongly supported by the frame members. Suspension is of the unsprung rocker beam type, providing a fully compensated eight twin-wheeled bogie ensuring even load distribution to all tyres. With 16 tyres in all, there are four short axles at the rear mounted in two lines of two axles; each axle is machined from bar or 7300kg/cm^2 (40 tons/in^2) tensile strength, and fitted with tapef roller bearing hubs of ample capacity.

The Crane Fruehauf 30-ton commercial-type semi-trailer for engineers' plant

General dimensions
Overall length (semi-trailer)12.46m (40ft 10½in)
Overall width 3·05m (10ft)
Height of platform 0·85m (2ft 9½in) laden
Ground clearance 381mm (15in) laden
Wheelbase (kingpin to centre line of rear bogie) 9·37m (30ft 9in)
Centres of suspension beams 1·52m (5ft)
Bogie wheeltrack 0·76m (2ft 6in)
Slope of ramp 1 in 6
Length of drop deck 8·64m (28ft 4in)

This is a cranked frame vehicle with facilities for loading over the rear suspension. The foredeck is of narrow design, fitted with 28·6mm (1⅛in) hardwood boards recessed between the main members to form a shallow tray. The main frame is of high-tensile steel universal beam 457mm × 190mm (18in × 7½in) on the maindeck with 356mm × 171mm (14in × 6¾in) on the foredeck. Frame cross members are 152mm × 89mm (6in × 3½in) rolled-steel joists with a steel box section member of 178mm × 152mm (7in × 6in) at the extreme rear. Suspension is of unsprung rocker beam type, with oscillating axles mounted at the ends of each beam to give full compensation between all wheels. Axles are constructed in solid form and oscillate on the rocker beams on plain bushes. Loading ramps are constructed from steel box section with 47·6mm (1⅞in) finished hardwood boards, plus auxiliary ramps. Landing gear is screw-operated, with feet fitted at the crank. Rear support jacks are mounted under the tail of the frame to give support while loading.

CRANE FRUEHAUF TRAILERS LTD
South Green Works, Dereham, Norfolk, England
Telephone: Dereham 2311 Telex: 97494



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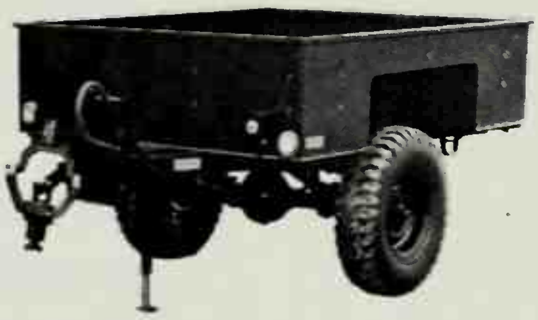

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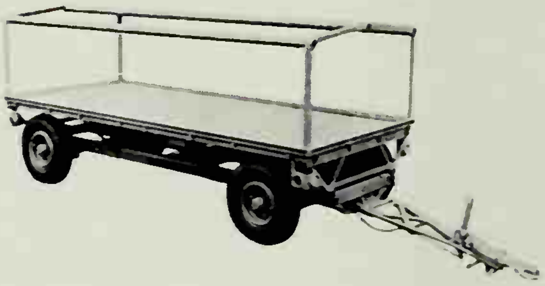

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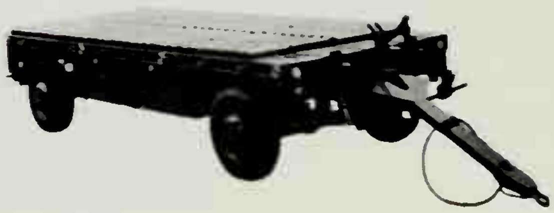

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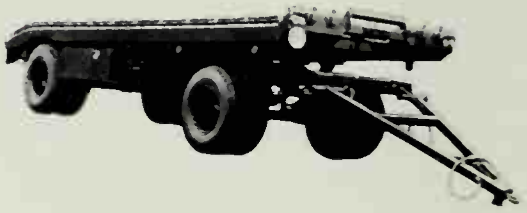

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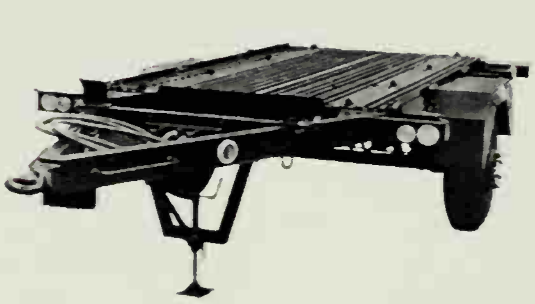

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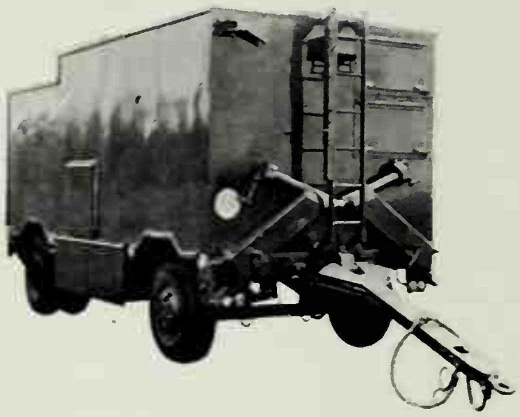

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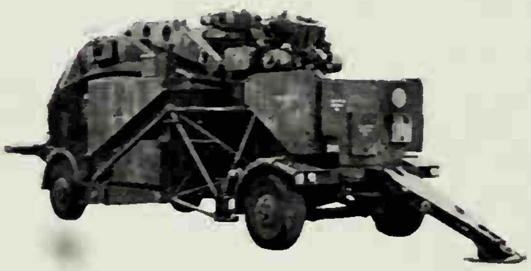

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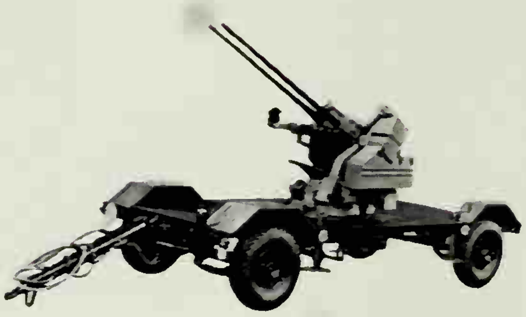


9

1 FV 2500 Series flat platform trailer (2 ton)

A general-purpose variant of the series FV2505 trailer. It is capable of shallow fording to a depth of 76·2cm (30in) in fresh or sea water

2 Power-driven cargo trailer

A two-wheeled trailer capable of being towed with or without mechanical drive to the wheels. The power-driven trailer role when coupled to the Land Rover gives a six-wheel driven train with high mobility over soft terrain

3 Basic chassis and platform (1¾ ton)

A light chassis developed for aircraft ground servicing equipment. It may also be fitted with a non-skid flat platform and canvas cover

4 FV 2800 Series 5-ton trailer

A general-purpose chassis trailer on to which various types of body can be fitted. The chassis construction is of the pressed channel welded type

5 FV 3200 Series recovery trailer (10 ton)

Designed and constructed for the recovery and transportation of all types of vehicle up to and including the 10-ton GS and CT wheeled vehicles

6 FV 2800 Series trailer for medium girder bridge

The primary role of this trailer is its capability to carry a single-storey bridge in palletised load form. Its secondary role is as a general-purpose flat trailer

7 FV 2800 Series radar trailer (7½ ton)

Designed to house and transport radar No 10 Mk 1. The body is of welded steel construction with riveted aluminium panels externally and hardboard panels internally

8 FV 2800 Series radar trailer (5 ton)

Designed to carry a height-finding radar aerial. Suspension restraining gear is fitted at each wheel station to facilitate deployment

9 FV 2500 Series gun-mounting trailer (2 ton)

Similar to 2-ton flat platform trailer (see item 1) but modified to accommodate 30 mm gun mounting

Military trailers

powered and unpowered

As the parent company of the Owen Organisation, a group of over 80 companies, Rubery Owen has extensive engineering interests. This has enabled the company to undertake the design and manufacture of a wide range of military equipment for the British Government.

Close collaboration between the British Military Vehicles and Engineering Establishment and Rubery Owen has resulted in several outstanding trailer designs, many of which are also suitable for civilian application where the terrain is exceptionally difficult.

The skill, ability and extensive manufacturing facilities of Rubery Owen and its associated companies are now available to overseas governments. The special purposes for which the vehicles are designed pose complex problems, but Rubery Owen has acquired from its past experience a unique amount of specialised knowledge which can apply to defence requirements in overseas territories.

Specifications

1 FV 2500 Series flat platform trailer (2 ton)

Dimensions
Height: 0·75m (2ft 6½in)
Length: 7·65m (25ft 2in)
Width: 2·36m (7ft 9in)
Track (front): 2·06m (6ft 9in)
(rear): 2·06m (6ft 9in)
Wheelbase: 3·66m (12ft 10in)
Weight laden: 5300kg (11 620lb)
Wheels
Rims: 6·50H × 16in divided
Tyres: 9·00 × 16in ply
Suspension:
Front and rear: semi-elliptical springs
Towing attachment
Type: front, draught eye
Brakes:
Service: two and three air line pressure system
Parking: mechanical handbrake
Service: in military service

2 Power-driven cargo trailer

Dimensions
Height (chassis top): 68·5cm (27in)
(body): 124·5cm (49in)
Length: 3·04m (9ft 11½in)
Width: 1·80m (5ft 11in)
Track: 1·51m (4ft 11½in)
Weight laden: 612kg (1350lb) (estimated)
Suspension
Semi-elliptical springs and Avon rubber assistors. Shock absorber: telescopic double-acting
Brakes:
Trailer: mechanical handbrake
Service: vacuum-operated
Transmission
Propeller shafts: Hardy-Spicer
Axle: spiral bevel
Service: prototype development

3 Basic chassis and platform (1¾ ton)

Dimensions
Overall length including tow bar:
4·42m with 2·43m frame (14ft 6in with 8ft)
5·03m with 3·04m frame (16ft 6in with 10ft)
5·64m with 3·65m frame (18ft 6in with 12ft)
Overall width: 1·53m (5ft 0¼in)
Height to top of frame: 0·48m (1ft 5in)
With platform fitted:
Width over kerbs: 1·58m (5ft 2½in)
Height to top of kerbs: 0·84m (2ft 9¼in)
Height to top of cover: 1·72m (5ft 7¾in)
Suspension: by means of rubber-in-sheer anti-vibration mountings
Service: in military service
Steering: Ackerman type actuated by the towbar
Brakes:
Mechanical on the rear wheels only and connected to an over-ride mechanism at the towing eye

4 FV 2800 Series 5-ton trailer

Dimensions
Overall height laden: 0·97m (3ft 2½in)
Overall length: 8·07m (26ft 5in)
Overall width: 2·32m (7ft 8in)
Track: 1·99m (6ft 7in)
Wheelbase: 3·95m (12ft 11in)
Suspension
Front and rear: semi-elliptical springs with telescopic hydraulic dampers
Service: in military service
Brakes:
Service: two and three line air pressure on all wheels
Parking: screw-operated on rear wheels only
Steering: Ackerman type

5 FV 3200 Series FV3221 recovery trailer (10 ton)

Dimensions
Height: 1·90m (6ft 3in)
Length: 7·28m (23ft 10½in)
Width: 2·74m (9ft)
Track (front): 2·06m (6ft 9in)
(rear): 2·06m (6ft 9in)
Wheelbase: 4·27m (14ft)
Weight
Unladen: 7130kg (15 700lb)
Laden: 20 067kg (44 240lb)
Brakes:
Service: two and three line air pressure system
Parking: mechanical, rear wheels only
Steering: Turntable
Suspension
Semi-elliptical springs front and rear
Service: in military service

6 FV 2800 Series FV2842 trailer for medium girder bridge

Dimensions
Overall height laden: 2·62m (8ft 7in)
Chassis height laden: 0·84m (2ft 10in)
Overall length: 5·85m (19ft 3in)
Overall width: 2·6m (8ft 7in)
Track: 2·27m (7ft 5in)
Weight laden (estimated): 4672kg (10 300lb)
Service
Prototype development
Brakes:
Service: two and three line air pressure hand mechanical
Sealed 12·7cm (5in) wide brakes
Suspension
Semi-elliptical springs. Rubbery bump stop with wire rope rebound slings

7 FV 2800 Series FV2824 radar trailer (7½ ton)

Dimensions
Height: 2·97m (9ft 9in)
Length: 6·26m (20ft 6½in)
Width: 2·53m (8ft 3½in)
Track (front): 2·0m (6ft 7in)
(rear): 1·78m (5ft 10in)
Wheelbase: 3·2m (10ft 6in)
Weight laden: 9860kg (21 750lb)
Brakes:
Service: two line air pressure on all wheels
Parking: screw operated on rear wheels
Steering: Ackerman type
Suspension
Semi-elliptical springs front and rear
Shock absorbers, telescopic hydraulic

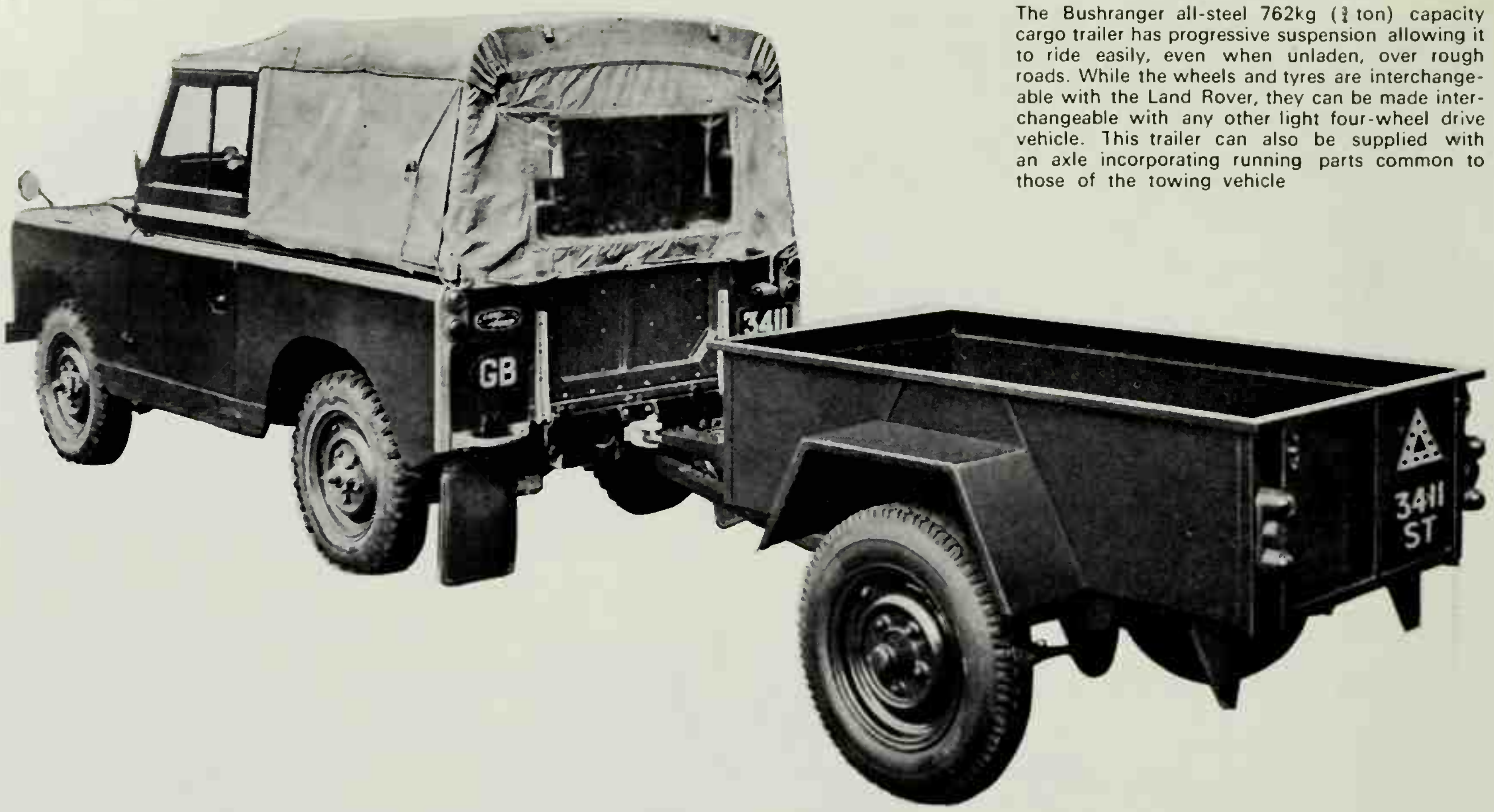
8 FV 2800 Series FV 2828 radar trailer (5 ton)

Dimensions
Height: 2·95m (9ft 8in)
Length: 9·61m (31ft 6½in)
Width: 2·66m (8ft 8¾in)
Track (front): 2·24m (7ft 4in)
(rear): 2·23m (7ft 3½in)
Wheelbase: 4·88m (16ft)
Weight laden: 9344kg (20 600lb)
Brakes:
Service: two and three line air/hydraulic
Parking: mechanical/hydraulic
Steering: Ackerman type
Suspension
Front: semi-elliptical springs; rear: coil shock absorbers, double-acting hydraulic telescopic

9 FV 2500 Series gun-mounting platform trailer

This trailer is basically similar to the 2-ton flat platform trailer (item 1, above) but modified to accommodate a 30 mm gun mounting. Length is reduced to 7·01 m (23 ft ½ in). Weight (including mounting) is 3700 kg (8157 lb). Brakes are three-line air pressure (one or two-line systems optional), hydraulic front and mechanical rear, with mechanical parking brake on rear. NATO standard 24 V electrics. Hand-operated screw jacks with 377 mm (14⅞ in) max lift allow trailer to be lowered on to ground plates after wheels are removed, to provide stable firing platform. Chassis frame is stiffened and machined to accept gun mounting and securing bolts.

A member of the Owen Organisation
RUBERY OWEN & COMPANY LIMITED
Special Equipment Division
PO Box 10, Darlaston, Wednesbury, Staffordshire, WS10 8JD, England
Telephone: 021-526 3131 Cables: Ruberowen Telex Darlaston Telex: 338236

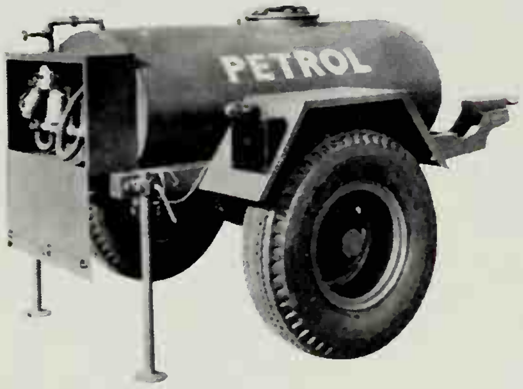


The Bushranger all-steel 762kg (¾ ton) capacity cargo trailer has progressive suspension allowing it to ride easily, even when unladen, over rough roads. While the wheels and tyres are interchangeable with the Land Rover, they can be made interchangeable with any other light four-wheel drive vehicle. This trailer can also be supplied with an axle incorporating running parts common to those of the towing vehicle

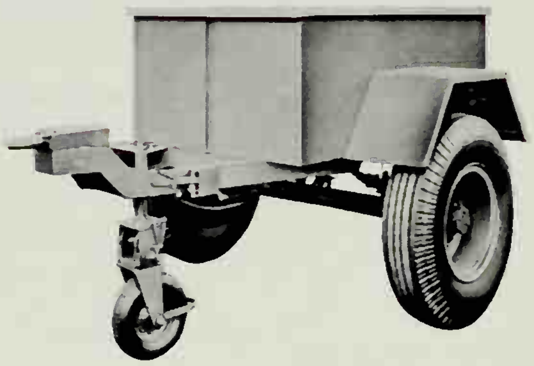
The Scottorn Bushranger illustrated above is, as in the case of those illustrated opposite, a trailer designed by Scottorn Limited to meet the tough conditions which prevail in many parts of the world. All Scottorn trailers are the subject of continuous testing programmes both in the UK and overseas, particularly in Africa and Asia, where much experience has been gained by the operation of trailers with military forces.

While the trailers shown here satisfy many possible military requirements, Scottorn Limited provides a design service to accommodate other needs which may arise, especially making mobile special equipment required by military forces.

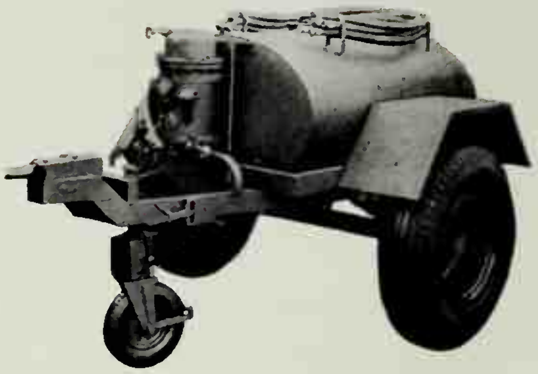
Some of the special-purpose trailers made by Scottorn. Details of others can be supplied on request.



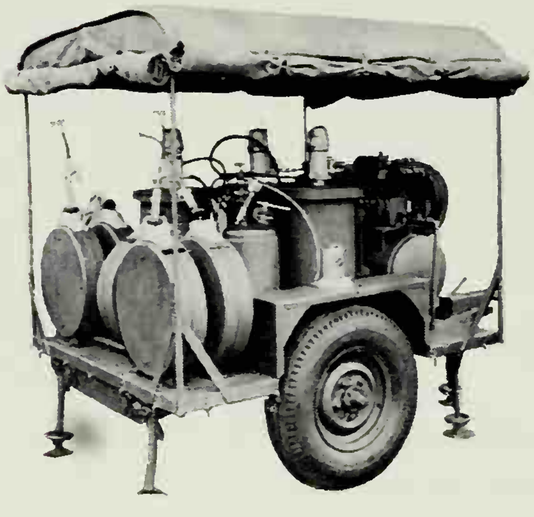
The Military R 1368 litre (300 gal) petrol tanker trailer is designed for use with the Bedford R type vehicle. All its brake components and wheels are interchangeable with those of the towing vehicle. The steel-plate tank has a 41 cm (16 in) manhole with a pressure/vacuum seal and breather. Petrol is taken off through a No 2 semi-rotary hand pump which delivers 41 l/min (9 gal/min). A 3 m (10 ft) heavy-duty hose, fitted with a trigger nozzle and an in-line flow meter, are housed in a rear locker. Electrical connections are by standard NATO 12-pin plug. The towing shaft is suitable for the standard NATO rotating hook. A 9 litre (2 gal) foam extinguisher is supplied



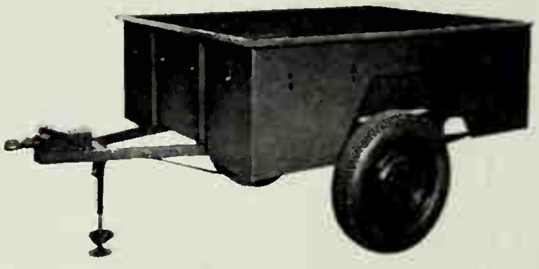
The Military R 1016kg (1 ton) trailer has been specifically designed for use with the Bedford R-type vehicle and incorporates in its axle hubs, drums, brakes, bearings, etc. identical to those utilised in the rear axle of the vehicle; the wheels and tyres are also interchangeable. As with many of the other Scottorn trailers, a progressive suspension system is used, allowing for smooth riding over the roughest surfaces. A salient feature of this trailer is the heavy-duty jockey wheel which allows easy movement of the trailer when solo



The Military R 1140 litre (250gal) capacity tanker trailer has an axle, wheels, tyres, suspension and other items common with those of the Military R cargo trailer. It is designed for carrying drinking water and has, as part of its standard equipment, a Stellar filter which is utilised to filter the water before it is pumped into the galvanised tank mounted on the robust chassis. Water is taken off by means of a gallery incorporating five taps at the rear of the trailer



The 508kg (½ ton) light mobile servicing trailer is normally used with a light four-wheel drive vehicle such as the Land Rover. Incorporating Tecalemit equipment suitable for servicing all types of vehicles, it has an independently powered compressor unit which, in addition to supplying compressed air to the lubricating equipment, is used for inflating tyres, spray painting and spark plug servicing



The Military L 762kg (¾ ton) capacity cargo trailer Mk 11A uses the same axle and suspension as the Bushranger but the body is a full-width unit allowing for greater cubic capacity. If required, this trailer can be supplied as an amphibious unit and will float with a 23cm (9in) freeboard with a load of 508kg (½ ton)

Trailers

with powered and unpowered axles

The Bushmaster powered-axle trailer has been designed to operate with the standard 2¼ litre 277cm (109in) wheelbase Land Rover or the series 9 WD Land Rover modified by the addition of a power drive shaft and vacuum brake system. The object has been to provide a two-wheeled power-driven trailer to give maximum mobility under conditions of low surface adhesion and to improve performance over rough and undulating terrain carrying, in conjunction with the Land Rover, a total load of 1778kg (1¾ tons).

The layout of the transmission system allows the trailer to articulate 60 deg either side of its central position in the vertical or horizontal plane.

The Land Rover is fitted with an extra transfer gearbox, bolted to the cross member behind the main gearbox, which splits the drive to the rear axle. A power-take-off is fitted and connected to a propeller shaft which is attached to a rear bearing. It passes through a hole in the rear cross member and terminates in a standard six-spline shaft. The trailer transmission consists of a short intermediate shaft with a universal joint at each end. One end is attached by a quick-release coupling to the splined power-take-off shaft mounted on the rear cross member of the Land Rover, the other end by a quick-release coupling to the main telescopic propeller shaft which drives the trailer axle The latter coupling is supported by a swinging arm.

The chassis frame is constructed from cold pressed steel channel section. Two side members form an A-frame at the front and are braced by four cross members.

The suspension comprises semi-elliptic dual-rated leaf springs with Aeon rubber springs and telescopic shock absorbers.

A brake system is provided through a mechanical linkage and compensator to the brake shoes. The brake system is operated by the over-run of the trailer. The hand parking brake operates through a common mechanical linkage. Vacuum-assisted braking supplied as an optional extra.

The only components which require lubrication are the universal joints and axle casing. All other bearings are either pre-packed or dry and all bearings are protected from mud and water by shields. A stabilising jack leg is fitted at the front of the trailer and either one or two may be fitted to the rear if required. The towing eye and hook has been designed to meet NATO standards.

Standard tyre equipment is 7·50 × 16 six-ply rating although 9·00 × 16 and 9·00 × 15 sand tyres are available as optional extras.

Specification: Bushmaster

Land Rover with trailer
Gross train weight unladen: 1942kg (4283lb)
Gross train weight laden and two persons: 3902kg (8603lb)
Trailer weight unladen: 445kg (982lb)
Gross payload of tractor and trailer: 1778kg (1¾ ton)
Maximum tractive effort: in four-wheel drive under low surface adhesion of 0·25 = 610kg (1345lb)
Laden low gear: in six-wheel drive under low surface adhesion of 0·25 = 1098kg (2420lb)
Maximum speed = 64km/h (40mph) on road, 32km/h (20mph) cross country
Range of action 402km (250 miles)
Maximum gradient: for stop-start 1 in 4
Maximum gradient: 1 in 3 (gravel surface)

Trailer
Overall length: 3·160m (124⅜in)
Overall width: 1·625m (64in)
Height of chassis from ground, laden: 0·641m (25¼in)
Departure angle laden: 30 deg
Track: 130cm (51½in) with 7·50 × 16 tyres
135cm (53½in) with 9·00 × 16 tyres
Optional choice of 6 × 6, 6 × 4 or 6 × 2 drive
Body size internal: length 211cm (83in)
width 152cm (60in)
height 53cm (21in)
Between wheel arches: 96cm (38in)

Scottorn's Mk 2 Bushmaster has been subjected to rigorous tests covering several thousands of miles on test tracks and normal roads. It was found that the engagement of the driven trailer axle—giving six-wheel drive—enabled the combination to negotiate steep, gravel-surfaced gradients (up to 1 in 2·79) and deep mud sections which failed non-driven axle trailers.

To add to its versatility the Bushmaster can be towed as an orthodox trailer without drive to its axle.

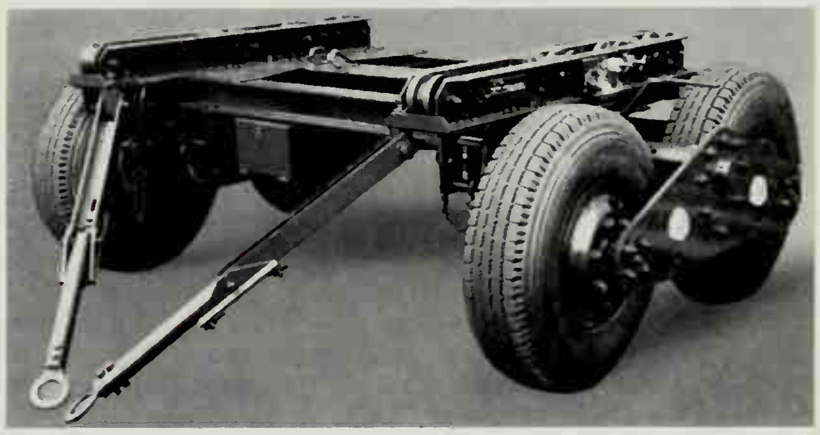
Existing 277cm (109in) WB and series 9 WD Land Rovers can be converted to use the Bushmaster by the fitting of a kit supplied by Scottorn Limited.

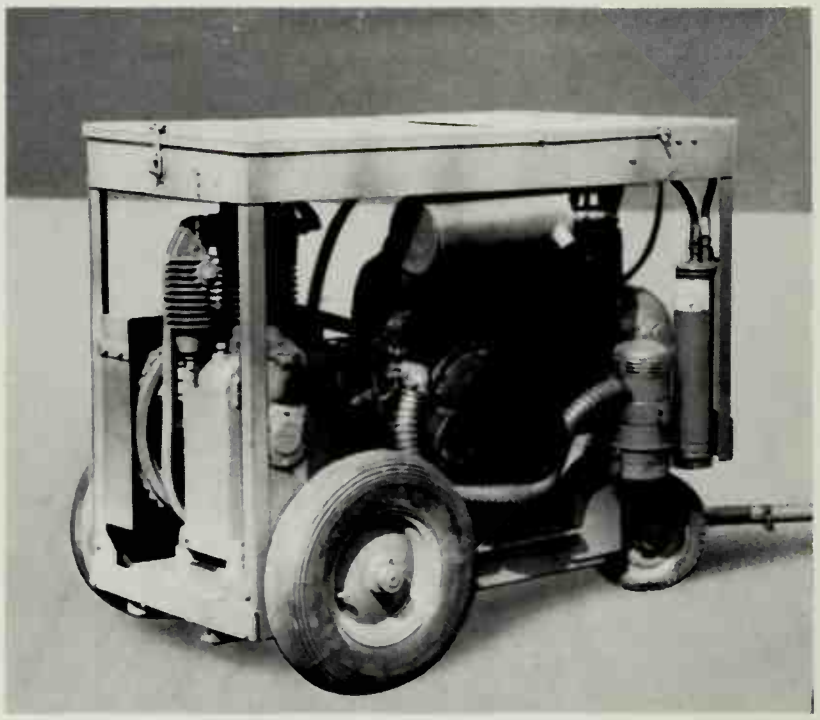
SCOTTORN LIMITED
Victor Works, Kingston Road, New Malden, Surrey, England
Telephone: 01-942 3633 Cables: Essenn New Malden

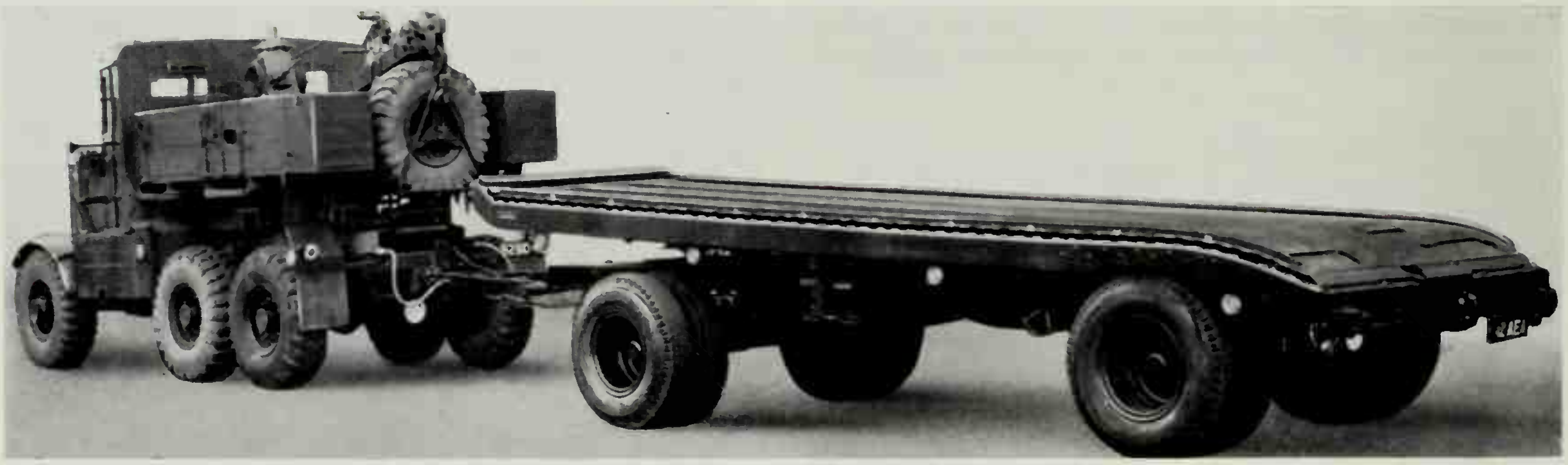
Trailers

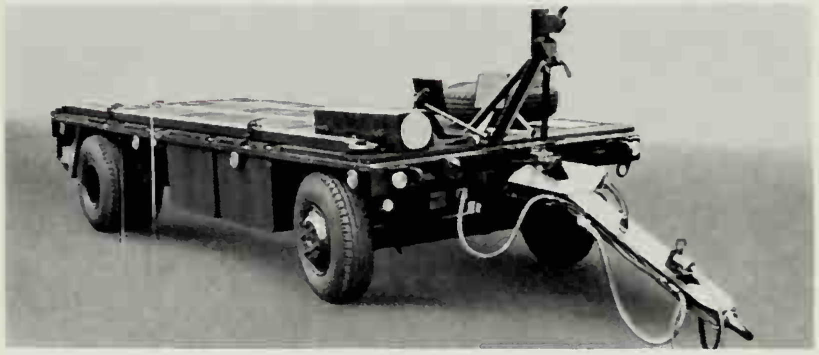
cargo and special-purpose types

Trailers and other wheeled epuipment to Ministry of Defence design are manufactured by this company under MGO Inspectorate approval.
A few examples from the wide range produced against MoD contracts are shown and enquiries are invited for reasonable production quantities of similar towed vehicles, or equipment, to MoD specification. (Tenders are subject to Ministry approval.)

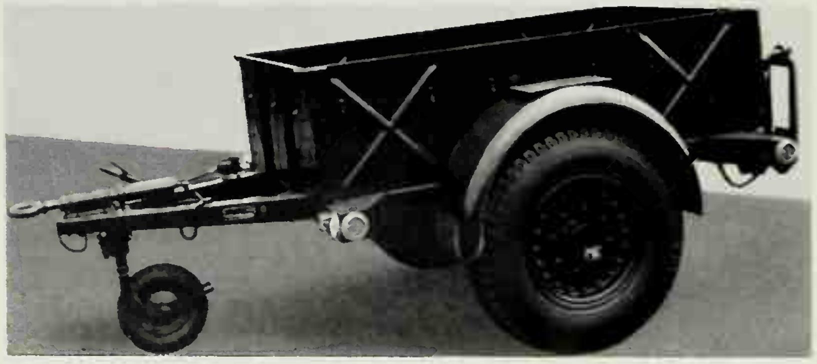

5-ton heavy ferry trailer (FV2861A)


Instrument and automatic pilot testing trolley Mk1A (Stores Ref. 4F/1715)

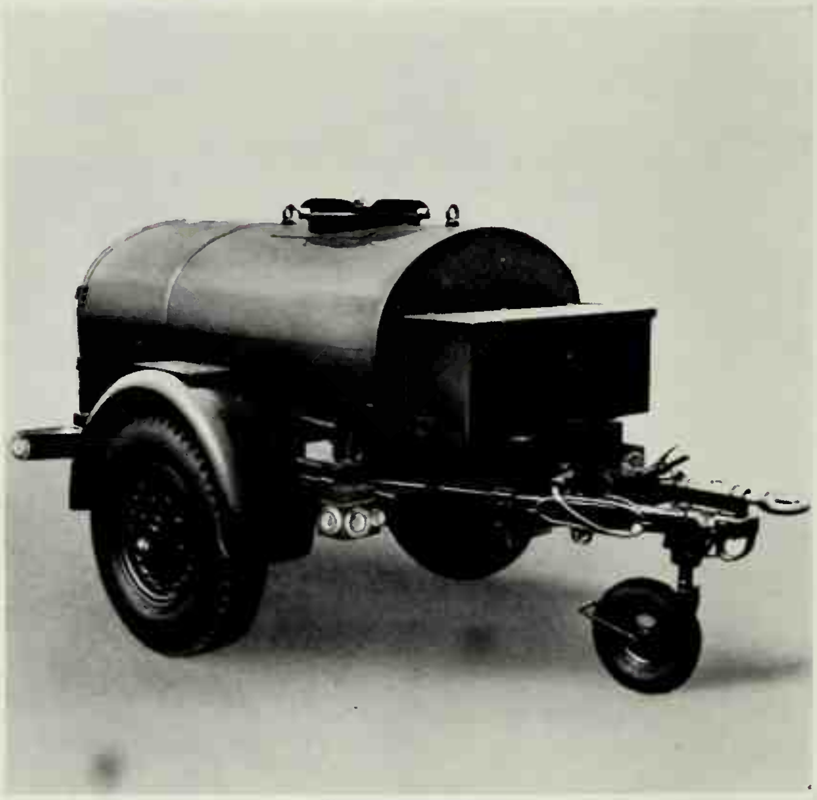

Above: 10 ton recovery trailer (FV3221A)


Above: 4-ton motor tug trailer Mk7 (FV2823A)

Below: 1-ton cargo trailer (FV2401A) and variants



Below: 910-litre (200-gal) water tank trailer Mk3

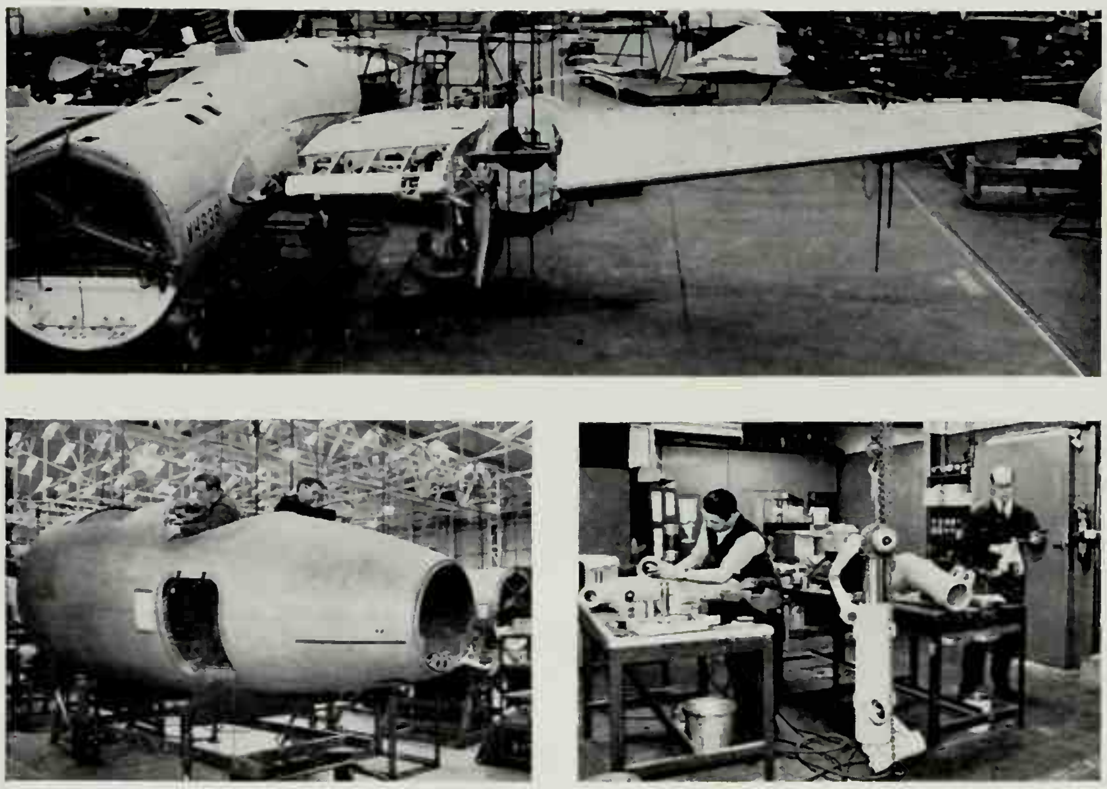


J BROCKHOUSE & CO LTD
Vehicles Division
Victoria Works, Hill Top, West Bromwich, Staffordshire, England
Telephone: 021-556 1241 Cables: Brockhouse West Bromwich Telex: 33631

Section 16

Aircraft and engines

A recently refurbished Canberra on low-level test flight



These photographs illustrate the depth of overhaul carried out on Canberras for resale. The programme includes a change of main-spar centre-section forging

Full facilities are available for technical representation, together with instructional courses for customer personnel at the BAC training school at Preston

Canberra

cost-effective combat and reconnaissance aircraft

Various Marks of Canberra, both bomber and photographic reconnaissance versions, are now being made available for resale after extensive refurbishing and overhaul at the Preston factories of the British Aircraft Corporation. Fitted with the latest instrumentation, radio and navigational equipment, these fine aircraft represent an effective combat and reconnaissance unit of continuing validity.

Continued operational effectiveness

The performance of the Canberra is far from obsolete and in fact coincides precisely with certain essential ground-attack performance criteria recently isolated as a result of operational experience. These criteria include a desirable attack speed of 350–450 knots, a single-pass weapons load of 1800–2300kg (4000–6000lb), the ability to accept a wide and easily varied range of armament and a realistic radius of action.

All these necessary characteristics are well within the Canberra performance capability of speed, range and load-carrying capacity. The available armament includes provision for bombs of 450kg (1000lb) or 230–255kg (500–540lb) with ballistic or retarded tails, air-to-air or air-to-ground rockets of varying calibres, podded guns and cannon, and guided air-to-ground missiles. In particular, the Canberra's great range enables operations to be mounted from rear bases immune from the risk of guerilla action in exposed forward areas, and long patrols to be maintained in the target area at low level. To this must be added the advantages of a comparatively uncomplicated and robust structure capable of high damage absorbency from ground fire. It has been shown that sophisticated aircraft are particularly vulnerable even to small arms fire at low level.

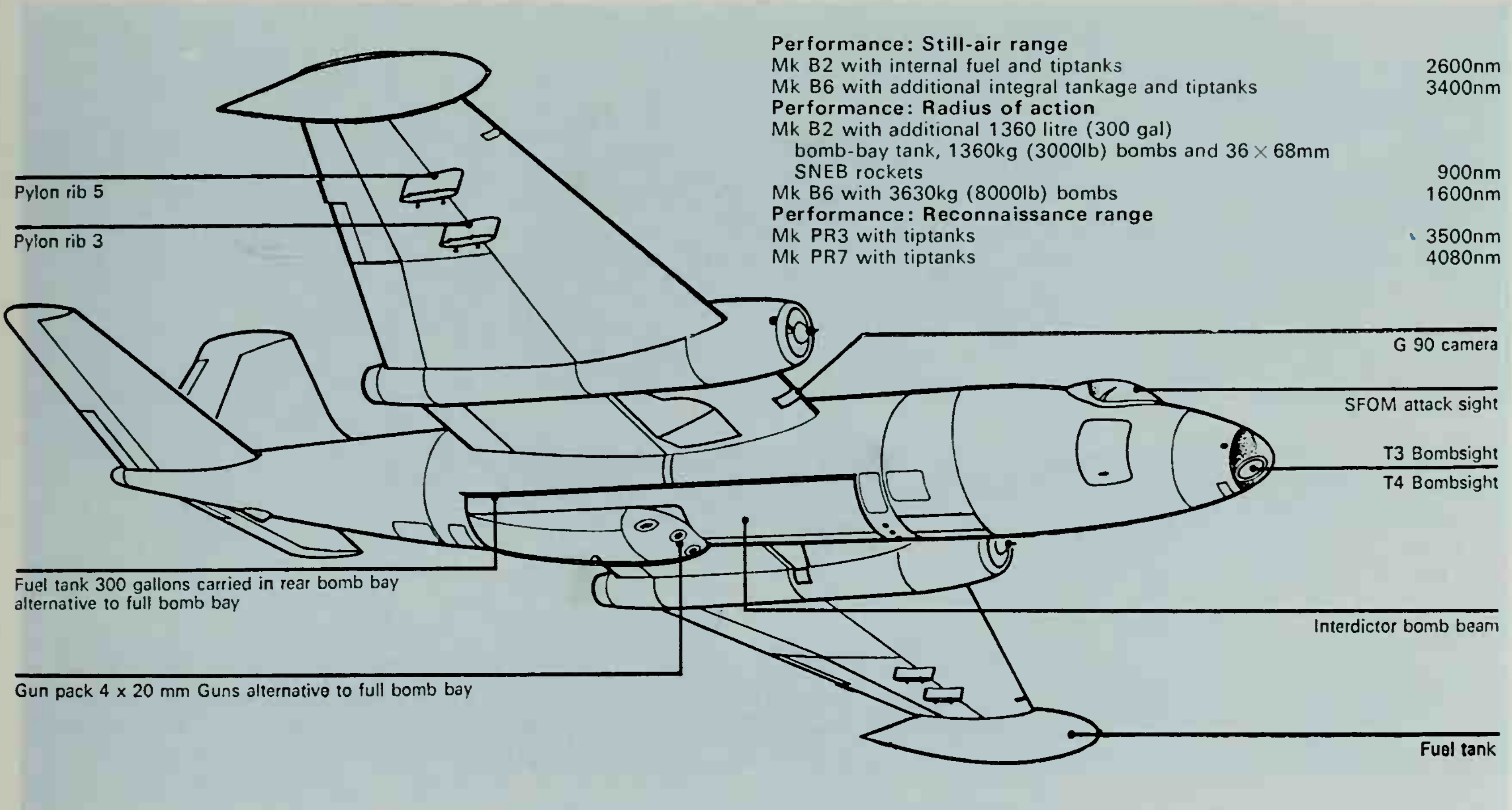
In the reconnaissance role Canberras can be fitted with various high, low and oblique camera installations to particular requirements.

Cost effectiveness

Initial cost of refurbished Canberras is highly competitive with any new aircraft capable of fulfilling the performance criteria described above. Operating costs are low by any military standards and significantly less than those for a sophisticated machine operating in the same roles. Time between major overhaul of airframe and engines is 1000h minimum.

After-sales service

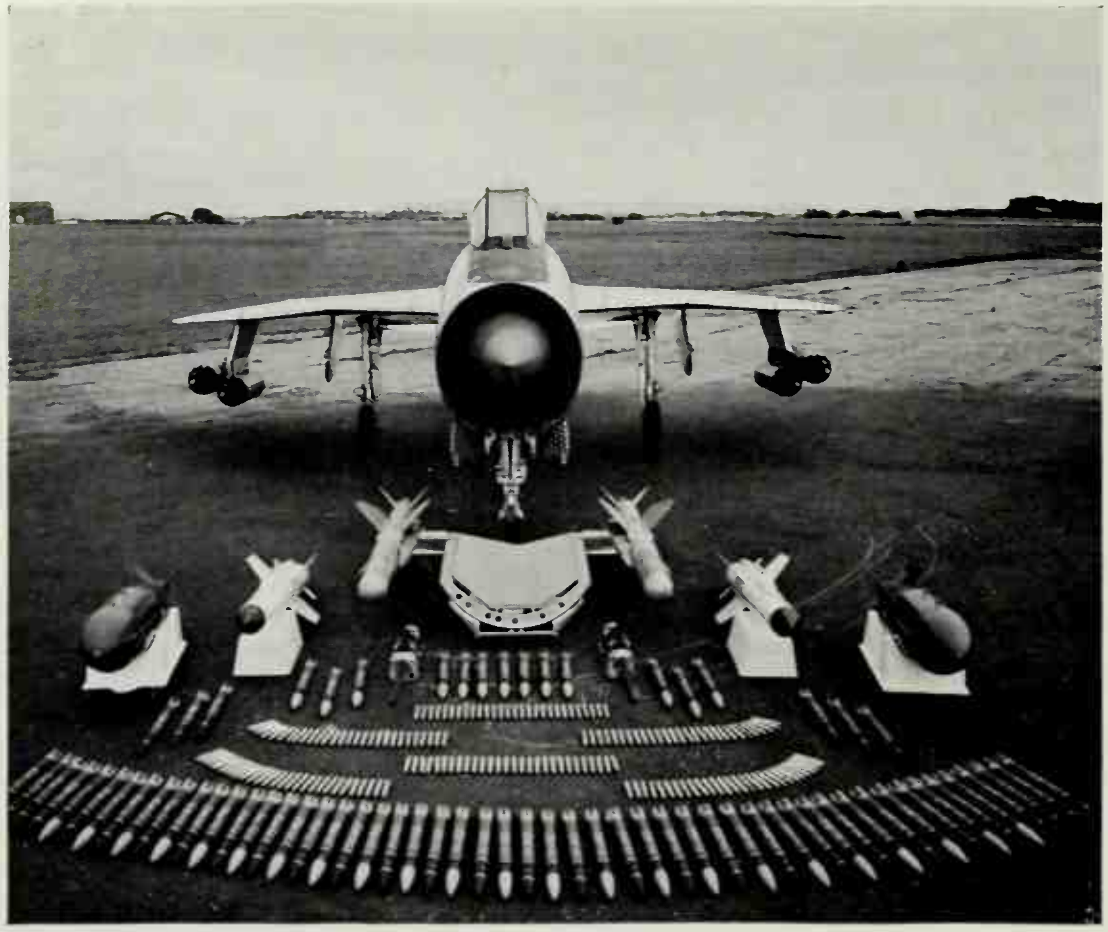
Canberra variants are first-line aircraft in 15 air forces throughout the world. Therefore a spares availability for at least ten years is assured for BAC-manufactured spares and equipment, while a policy of re-equipment with up-to-date instruments, radio and navigation aids ensures that the necessary spares backing is available for these vital ancillaries.


Pylon rib 5
Pylon rib 3
G 90 camera
SFOM attack sight
T3 Bombsight
T4 Bombsight
Fuel tank 300 gallons carried in rear bomb bay alternative to full bomb bay
Interdictor bomb beam
Gun pack 4 x 20 mm Guns alternative to full bomb bay
Fuel tank

Performance: Still-air range	
Mk B2 with internal fuel and tiptanks	2600nm
Mk B6 with additional integral tankage and tiptanks	3400nm
Performance: Radius of action	
Mk B2 with additional 1360 litre (300 gal) bomb-bay tank, 1360kg (3000lb) bombs and 36 × 68mm SNEB rockets	900nm
Mk B6 with 3630kg (8000lb) bombs	1600nm
Performance: Reconnaissance range	
Mk PR3 with tiptanks	3500nm
Mk PR7 with tiptanks	4080nm

Diagram showing Canberra weapon stations.

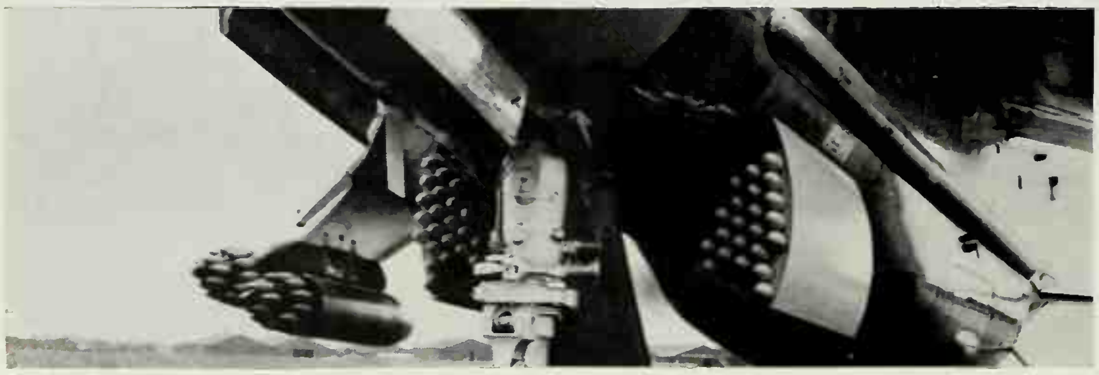
BRITISH AIRCRAFT CORPORATION
Preston Division
Warton Aerodrome, Preston, PR4 1AX, England
Telephone: St. Annes 21255 Cables: Britair Warton Telex: 67627



Some of the wide range of missiles, bombs (with ballistic or retarded tails), rockets and heavy-calibre guns available for the Lightning

44 rockets (2-in) in a ventral pack, 450kg (1000lb) bombs on wing-pylons, and two overwing fuel tanks carrying an additional 1180 litres (260gal) of fuel. Bombs or rockets can be fitted at these overwing stations instead of fuel; a combined twin rocket-launcher/227 litre (50gal) fuel tank is also available for overwing attachment. The latter provides a total additional fuel capacity of 910 litres (200gal)

Rotatable reconnaissance pack with camera ports exposed for photography. Gun pod with 2 × 30mm cannon installed in front portion of ventral pack



44 rockets (2-in) in the front fuselage with 72 rockets (68mm) beneath the wings

Lightning

high-low-high multi-mission aircraft

Powerful ground-attack capability

Already established as the world's finest interceptor, the Lightning, as a result of an intensive development programme, now has a high-performance ground-attack potential of formidable strength.

Under- and overwing weapons attachment stations enable it to carry in this role a wide spectrum of armament, bombs, rockets and cannon. For example, in one configuration no less than 188 rocket projectiles of both 2in and 68mm calibre can be carried. The mix of weapons can be varied to suit many operational requirements, over four hundred different combinations of load being feasible.

Mission change in minutes

In addition to missiles and weapons for high-altitude interception, and bombs, rockets and cannon for low-level attack, the Lightning can also carry out high-speed reconnaissance tasks utilising a pack contained within the fuselage for camera lens protection, and with capacity for the installation of side-looking radar and other reconnaissance electronics.

A change of role from interceptor to ground attack or to reconnaissance can be made in a minimum of time, frequently as little as one hour; the change of armament is the only between-sortie modification necessary.

Full potential in all roles

In all these roles the Lightning retains unimpaired its qualities of manoeuvrability, ease of handling and response to control which have proved it unexcelled as a weapons platform. Its high-performance radar equipment is retained in all tasks and supplemented by a light fighter sight for accurate air-to-ground target destruction and as a stand-by sight for air-to-air combat.

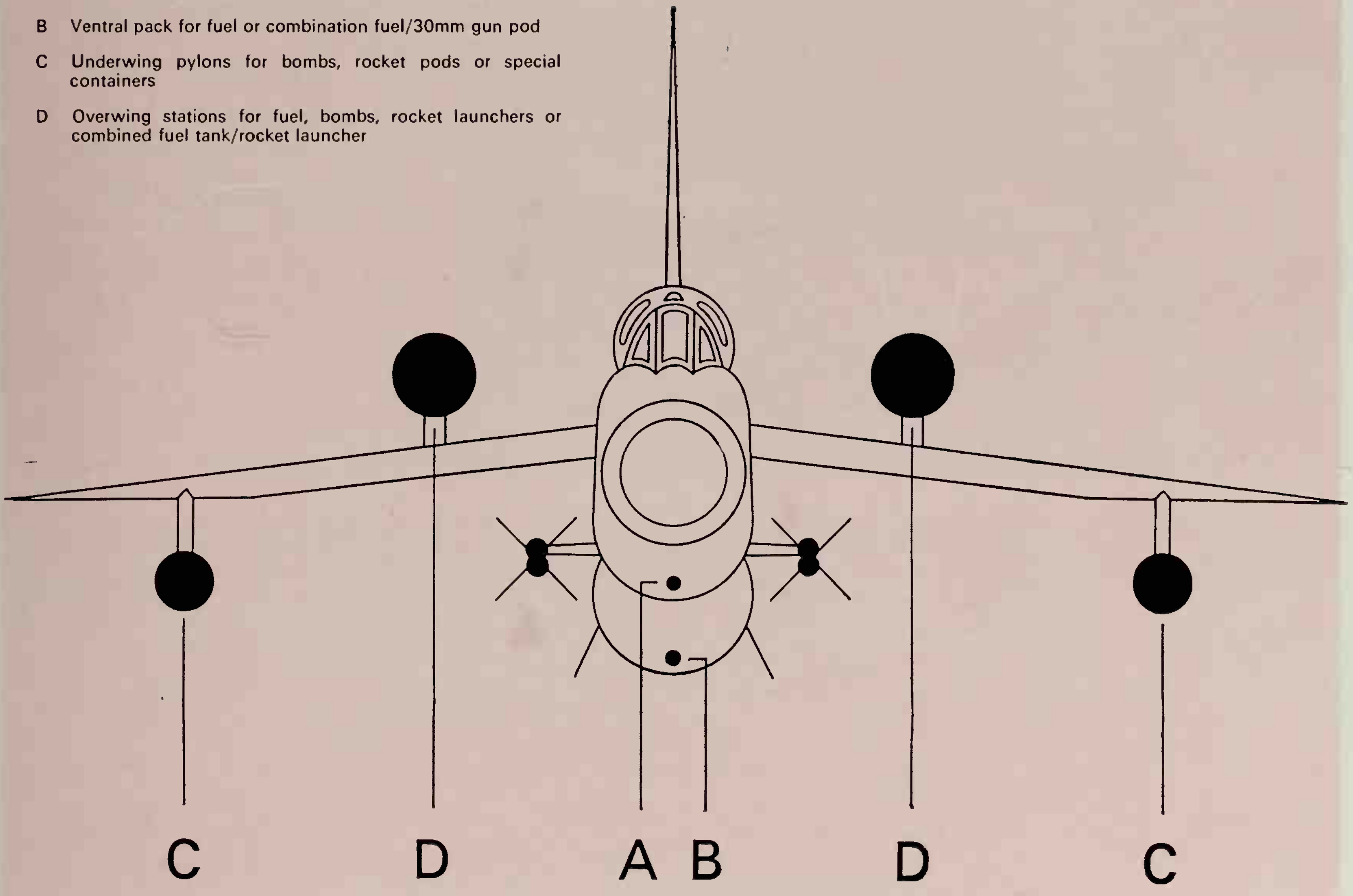
Diagram showing weapon stations on the Lightning:

A Front fuselage weapons bay and missile mounting

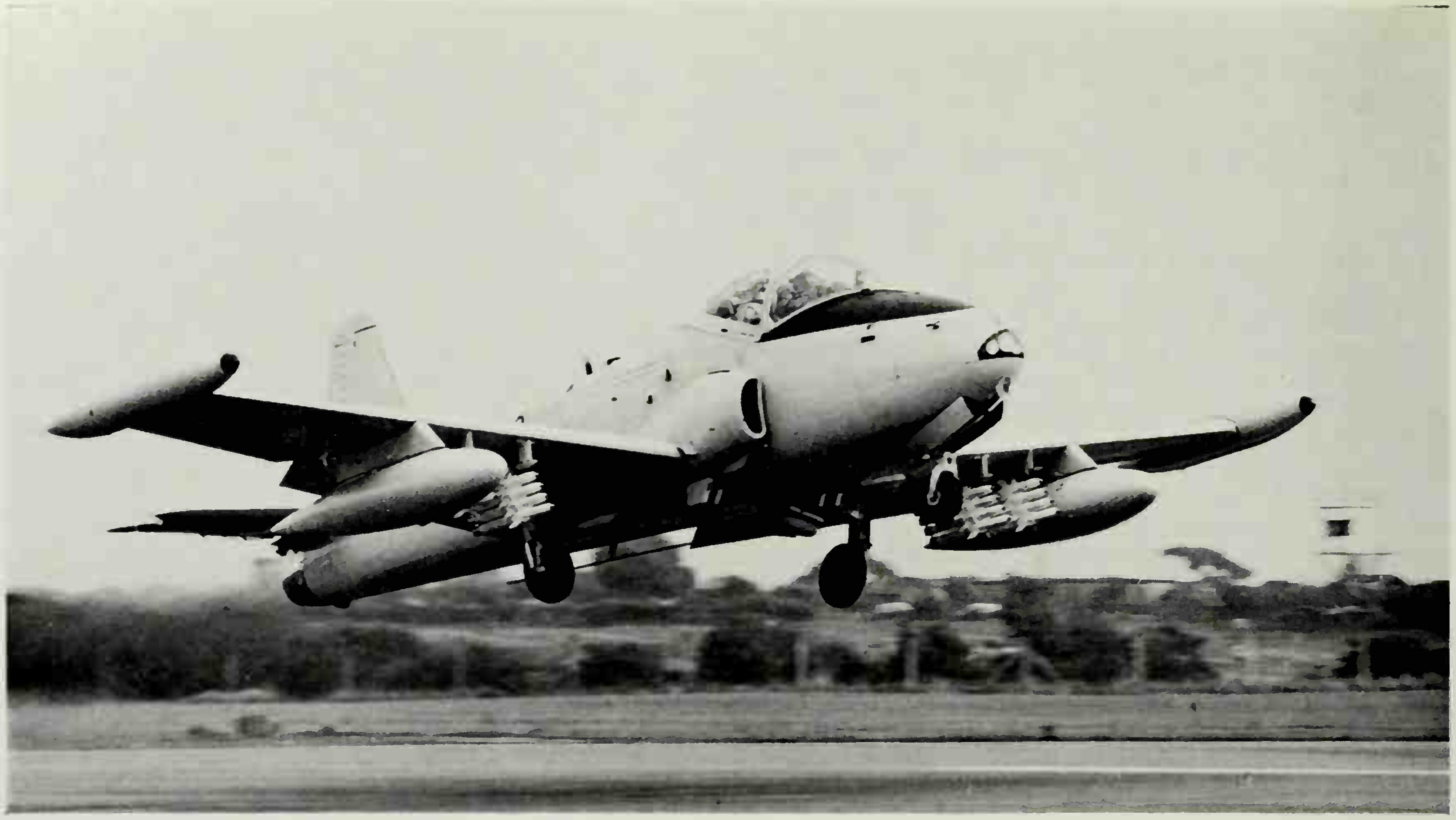
B Ventral pack for fuel or combination fuel/30mm gun pod

C Underwing pylons for bombs, rocket pods or special containers

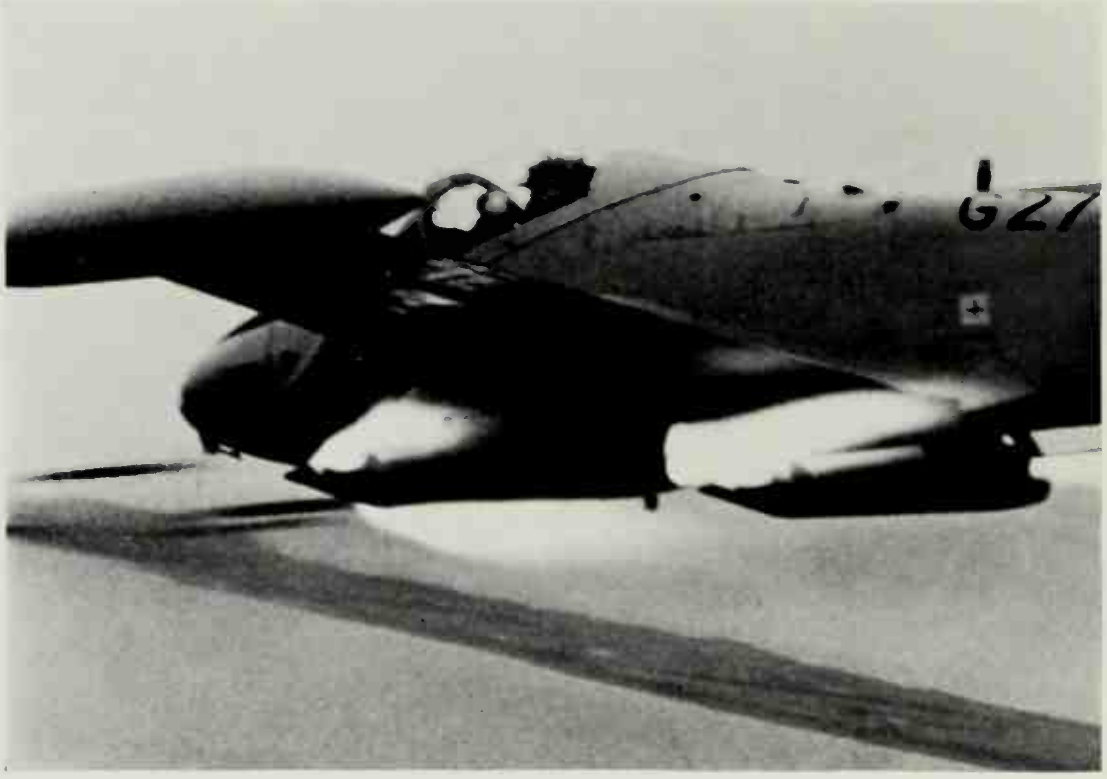
D Overwing stations for fuel, bombs, rocket launchers or combined fuel tank/rocket launcher



BRITISH AIRCRAFT CORPORATION
Preston Division
Warton Aerodrome, Preston, PR4 1AX, England
Telephone: St Annes 21255 Cables: Britair Warton Telex: 67627

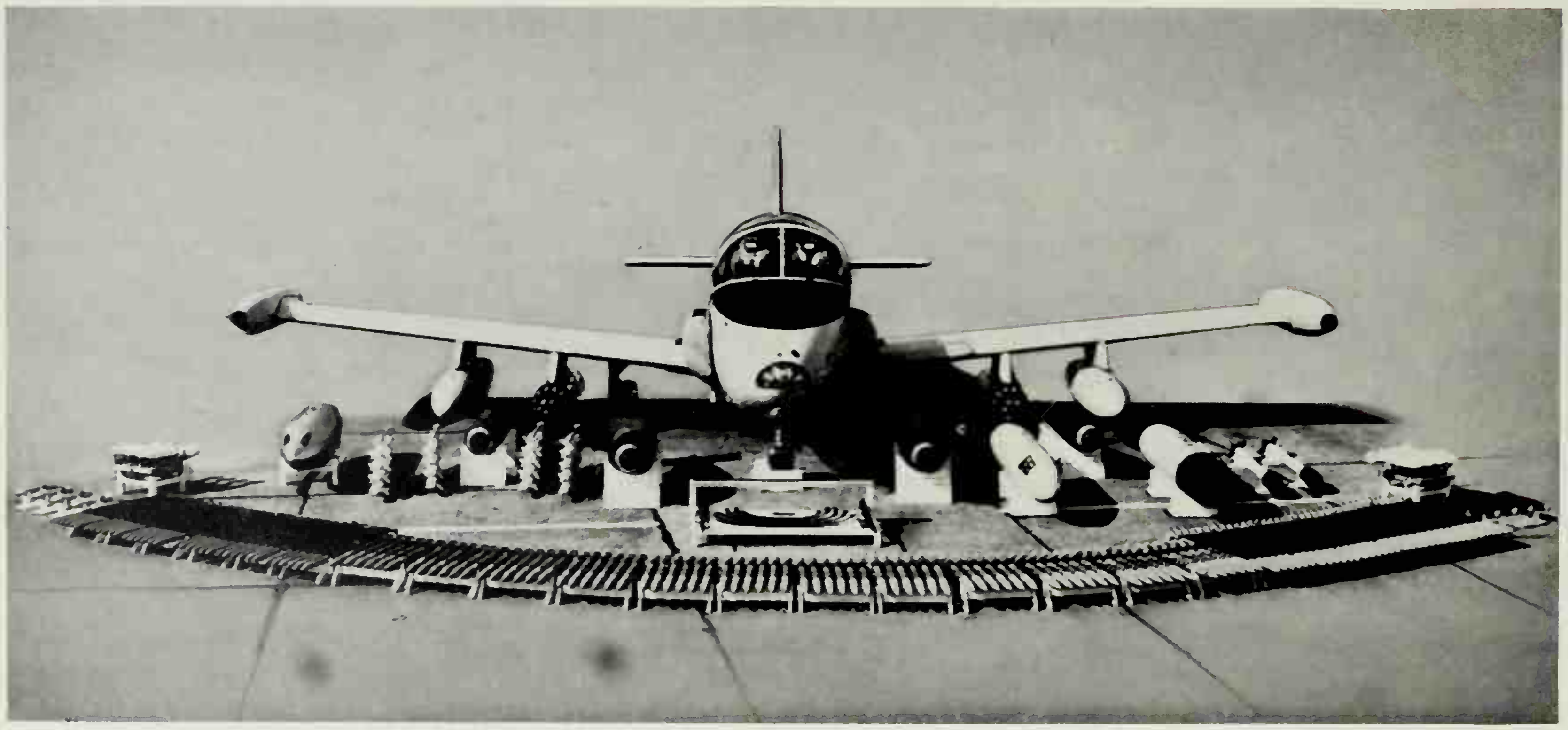


A BAC 167 Strikemaster takes off with two 340 litre (75gal) auxiliary fuel tanks at outboard underwing stations, 16 80mm SURA rockets at inboard underwing stations, and two 7·62mm guns and ammunition in fuselage mounting. In this configuration the Strikemaster has a radius of action of over 500 nautical miles



A salvo of 68mm rockets at the moment of launch from the Matra rocket pods beneath the wings of a Strikemaster. Outboard stations were empty on this occasion for trials recording purposes, but additional launchers or stores can easily be fitted at these points

Some of the wide range of armament available for the BAC 167 Strikemaster



Strikemaster

BAC 167 for pilot training and defence

BAC 167 Strikemaster variants are now being delivered and are on order for several air forces throughout the world. The dual capability of the Strikemaster has been a significant factor in this choice since it enables jet-powered aircraft to be introduced to project a soundly based defence plan, while incorporating simultaneous training to advanced standards with immediate availability for national security.

Two vital defensive concepts

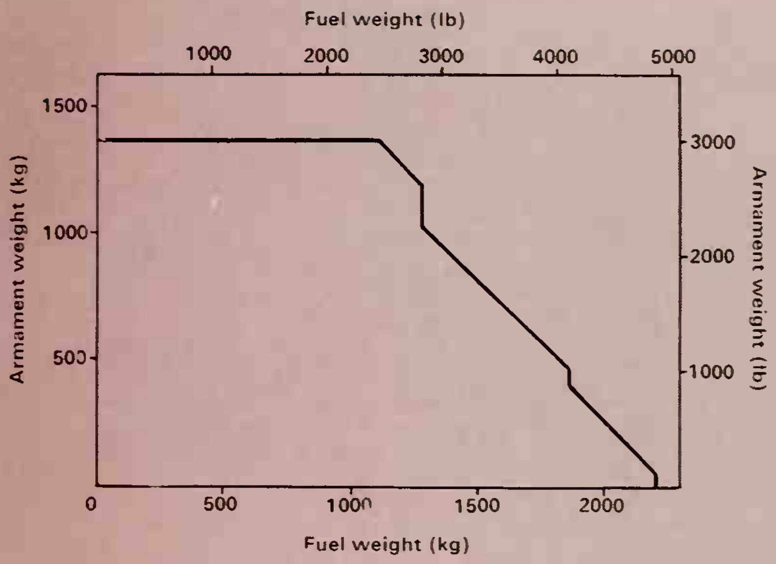
Not only is the BAC 167 Strikemaster a superb trainer for training up to a standard where easy transition to sophisticated supersonic machines can be achieved, but it also provides throughout this training period a powerful ground-attack and counter-insurgency weapon for national security. It is flexible, cost-effective and capable of integration into any projected or existing defence environment.

High operational effectiveness

Powered by the Rolls-Royce Viper 20 Mk 535 engine giving 1550kg (3410lb) s.t., the Strikemaster has a radius of action which can be varied from, for example, 250 nautical miles carrying 1360kg (3000lb) underwing stores, to over 600 nautical miles on an armed reconnaissance sortie. At 100 nautical miles from base it can 'loiter' in the target area at low level for over 2½h, or at 500 nautical miles can patrol for 35min followed by a gun attack.

Wide armament spectrum

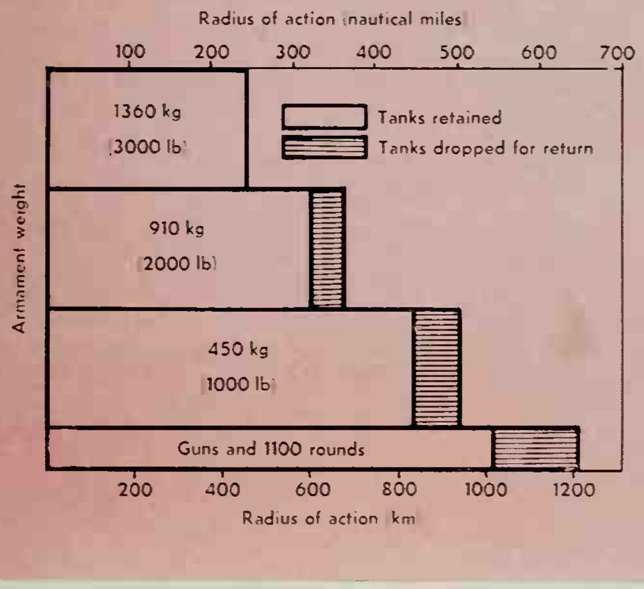
Armament capability includes 2in, 2·75in, 68mm, 80mm, 3in, and 5in rockets, bombs of heavy calibre with ballistic or retarded tails, and various gun pods. In all underwing store configurations the Strikemaster carries two 7·62mm fuselage guns with 1100 rounds of ammunition.

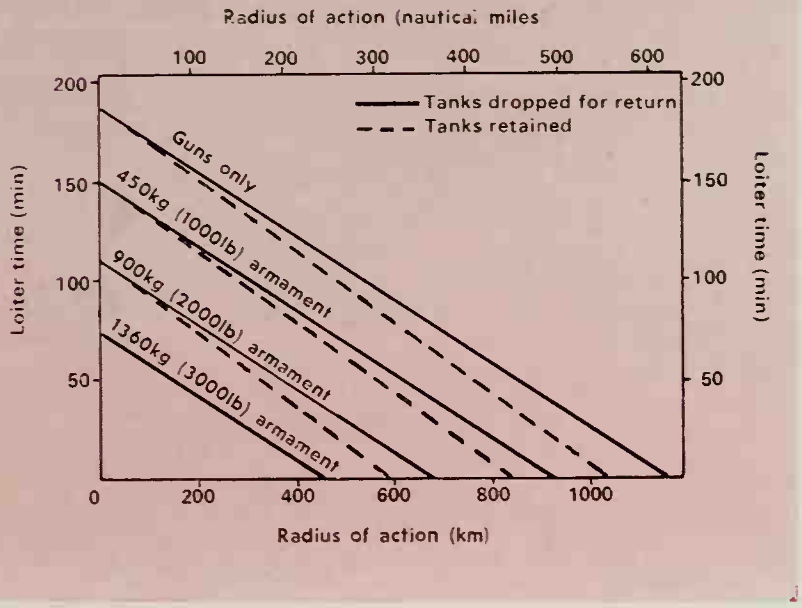


Operational effectiveness

The graphs illustrate the considerable potential of the BAC 167 as an armed ground-attack or counter-insurgency patrol aircraft. In compiling these charts allowances have been made for all operational factors affecting fuel consumption and weight carrying capability, while a realistic fuel reserve figure has been allowed for. Factors taken into account or assumed are:

1. Take-off and accelerate to climb speed
2. Climb to optimum cruise height
3. Cruise at optimum height
4. Descend to 1500m (5000ft)
5. Loiter at 1·15Vmd at 1500m (5000ft)
6. Attack for 3 minutes at 95 per cent power
7. Climb with tanks less stores after attack
8. Cruise at optimum height
9. Descend to circuit
10. 90kg (200lb) reserve fue
11. ISA conditions
12. Guns fitted with 1100 rounds ammunition





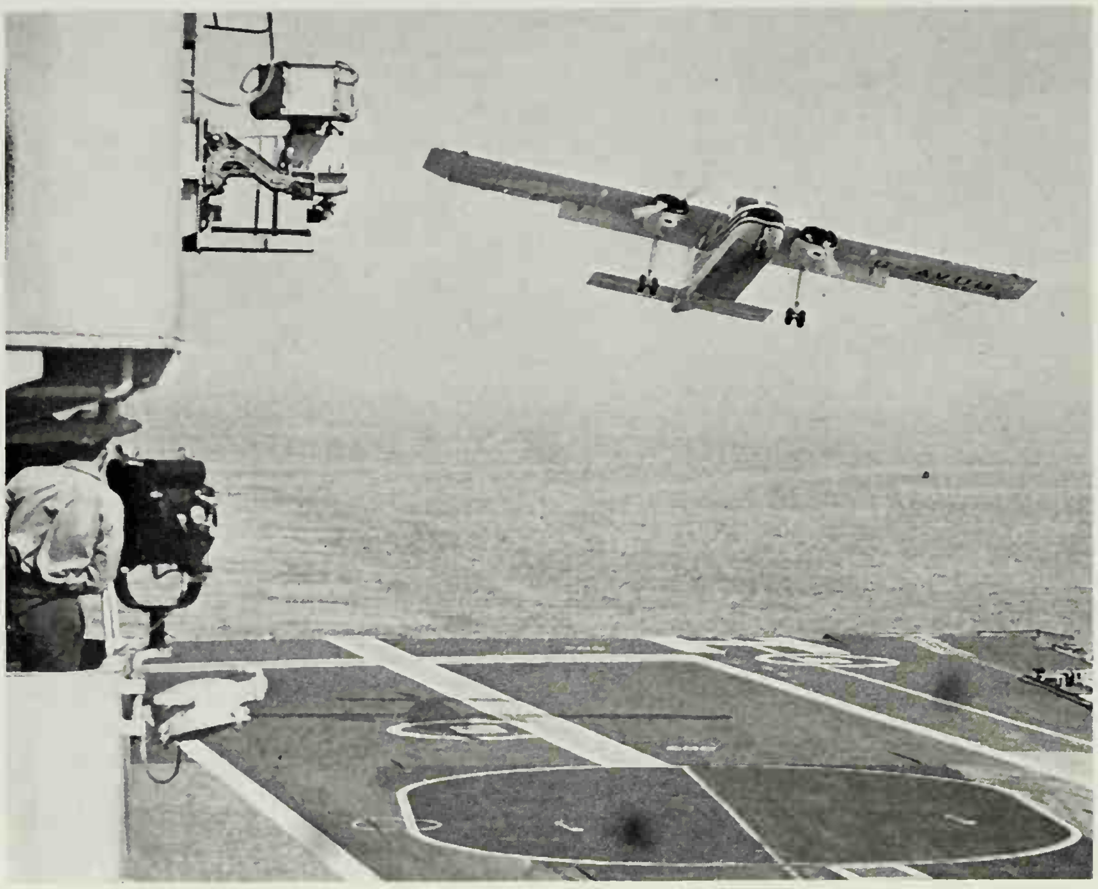
BRITISH AIRCRAFT CORPORATION
Preston Division
Warton Aerodrome, Preston, PR4 1AX, England
Telephone: St Annes 21255 Cables: Britair Warton Telex: 67627

Performance (unfactored)

ISA conditions at normal maximum weight 2860 kg (6300 lb). Short take-off and landing at sea level zero wind, dry hard surface.

2 × 260 hp Lycoming 0-540-E

Take-off run: 170 m (560 ft)
Take-off distance to 15 m (50 ft): 333 m (1090 ft)
Landing run: 137 m (450 ft)
Landing distance over 15 m (50 ft): 293 m (960 ft)
Sea level rate of climb, 2 engines: 5·3 m/sec (1050 ft/min)
Sea level rate of climb, 1 engine: 0·96 m/sec (190 ft/min)
Absolute ceiling: 4950 m (16 200 ft)
Sea level maximum speed: 274 km/h (170 mph)
Minimum control speed: 72 km/h (45 mph)
Stalling speed: 78 km/h (49 mph)
Cross wind velocity: 56 km/h (35 mph)



2 × 300 hp Lycoming I0-540-K

Take-off to 15 m (50 ft) at sea level: 287 m (940 ft)
Landing distance from 15 m (50 ft) at sea level: 293 m (960 ft)
Rate of climb, 2 engines at sea level: 6·3 m/sec (1260 ft/min)
Rate of climb, 1 engine at sea level: 1·3 m/sec (240 ft/min)
Single-engine ceiling: above 2440 m (8000 ft)
Cruise 75% at 2290 m (7500 ft): 274 km/h (170 mph)
Cruise 67% at 2740 m (9000 ft): 265 km/h (165 mph)

The Britten-Norman BN-2 landing on HMS *Hermes* during trials in April 1968

Islander

Britten-Norman BN-2 multi-purpose light transport

The BN-2 light transport aircraft gives dependable service under tough close-support field conditions. Maintenance is simple. The fixed undercarriage is virtually indestructible. The entire structure is completely corrosion-proofed. The BN-2 is a twin-engined aircraft which combines the capabilities of the best single-engine STOL aircraft with the payload/range performance of aircraft designed for long runway operation.

The roles of the BN-2 are: communications, logistic support, utility, parachute and supply dropping and casualty evacuation. A version is available for aerial reconnaissance. Low in first costs, economic to operate and maintain, the BN-2's cost-effectiveness is increased by its short-field performance and ability to operate from unprepared clearings, sand areas or Arctic wastes which converts any small clearing into a forward air base.

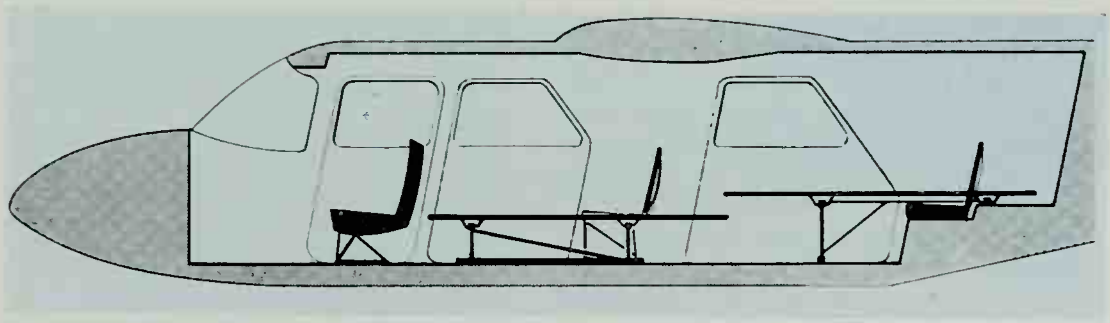
At its public transport gross weight of 2857 kg (6300 lb), the BN-2, powered by two rugged Lycoming 0-540 engines, can be airborne in 171 metres (560 ft) and land in only 137 metres (450 ft), from any reasonably flat ground.

In the Casevac role, the BN-2 can carry two sitting patients, two stretcher patients, plus attendants and medical equipment. The 4·77 m^3 (168·5 ft^3) cabin of the BN-2 can carry 900 kg (2000 lb) of supplies, ammunition and equipment, or eight fully equipped troops. The large rear door and high wing combined with the low minimum control speed make the BN-2 an ideal parachute or supply-dropping aircraft. As a ship-to-shore liaison aircraft, the BN-2 can land and take off fully loaded from a conventional aircraft carrier without catapults or arrester gear.

Numerous attachment points can be provided for the carriage of a wide assortment of underwing stores. The BN-2 is in quantity production and the basic equipment including propellers, brakes and instruments were chosen for their availability from commercial sources. Over 180 BN-2s are in world-wide operation.

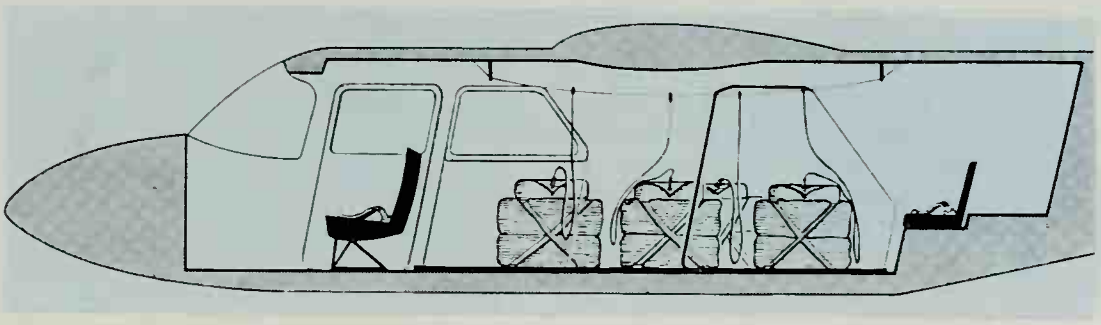
Casevac

As a combination forward support transport and air ambulance, the BN-2 offers maximum cost effectiveness. Provision is made for two sitting and two stretcher-patients plus medical attendants, with room to spare for extra payload or medical equipment.



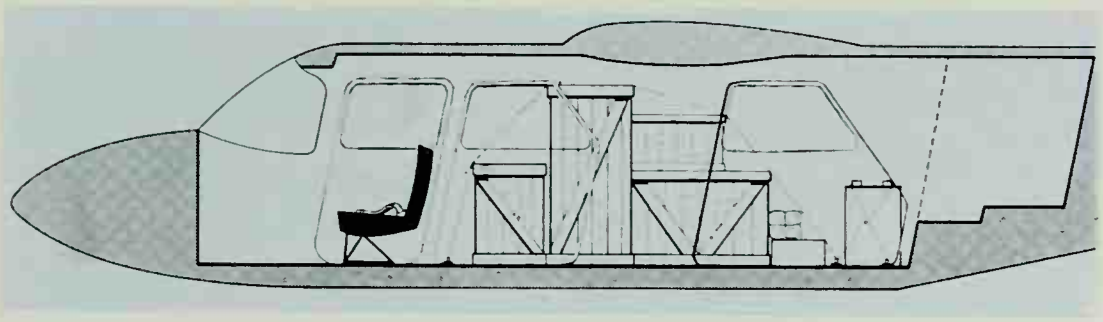
Supply drop

The BN-2's rear door is 122 × 112 cm (48 × 44 in) which means that sacks, large boxes and supply packs can all be delivered by the supply-drop BN-2. The BN-2 flies 320 km (200 miles) in just over an hour, has the ability to fly at low (83·4 km = 45 knots) speeds for accurate on-target supply drops. Numerous attachment points can be provided for the carriage of a wide assortment of underwing stores.



Logistic support

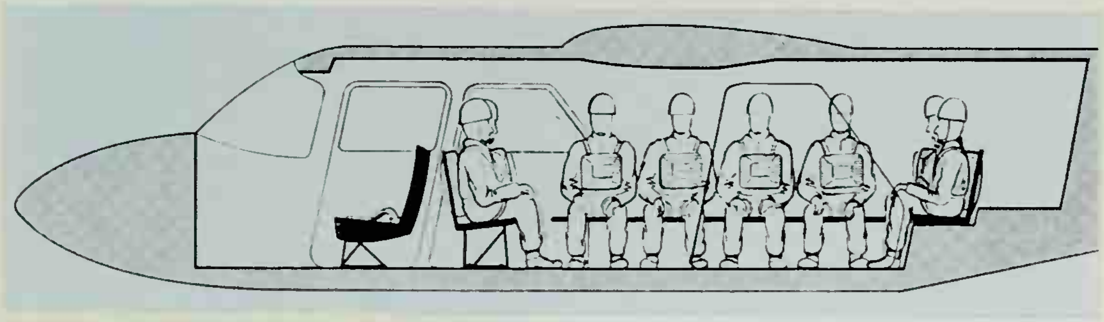
The BN-2 cabin is 427 cm (14 ft) long with a volume of 4·77 m^3 (168·5 ft^3). The BN-2 can take off and land in under 171 metres (560 ft) which means that any small clearing can be a forward supply base. Because of its low price the BN-2's cost effectiveness is many times greater than that of a helicopter offering equivalent payload.



Internal security

For the cost of one sophisticated aircraft, five or more BN-2s may be operated, each carrying eight troops—a unique combination of flexibility and cost effectiveness.

The BN-2 can take off from a standstill with one engine completely inoperative.



BRITTEN-NORMAN SALES LIMITED

Bembridge Airport, Bembridge, Isle of Wight, England
Telephone: Bembridge 2511 Cables: Britnor Bembridge Telex: 86277

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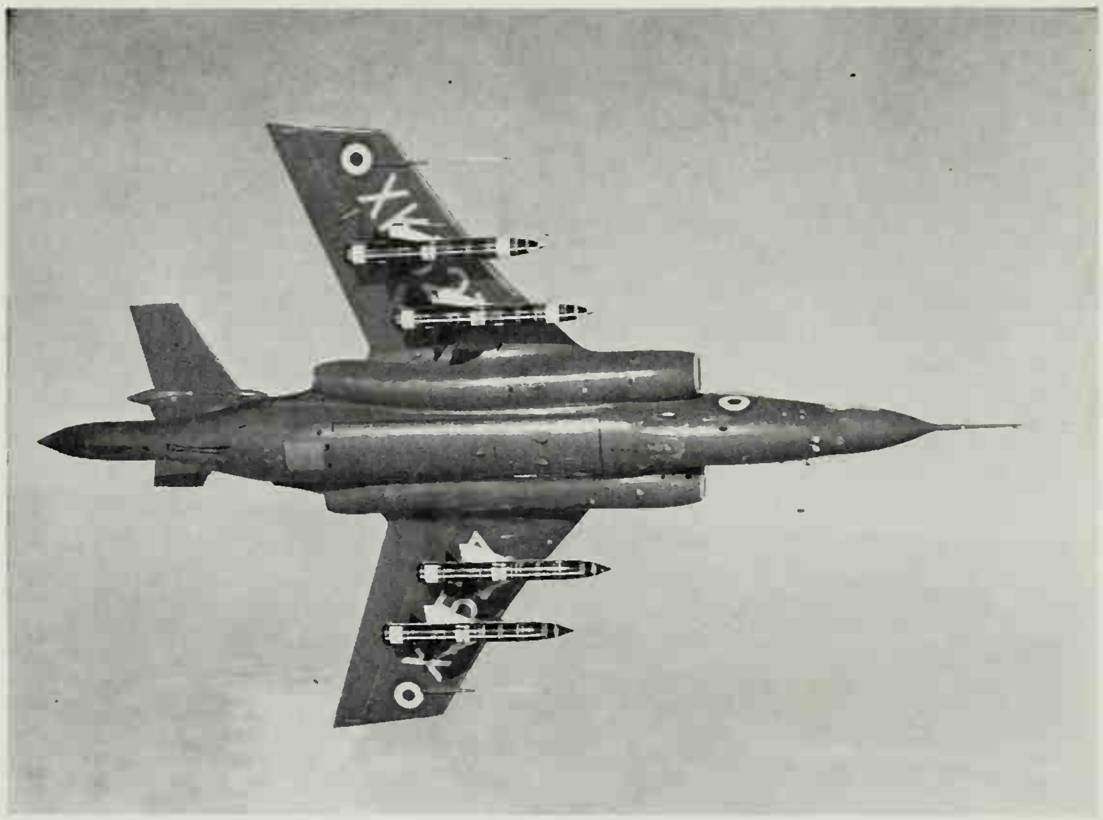


The Buccaneer was designed from the outset as a low-level high-speed weapon system. The use of high-strength steel wing spars and outer wing skins machined from the solid give high strength and durability. Special forward-looking and avoidance radar enable the aircraft to stay below the detecting radar horizon, while the high load-carrying capacity gives it an outstanding attack capability.

The long range and transonic speed combined with comparatively low take-off and landing speeds (achieved by boundary layer blowing) result in exceptional flexibility, while some of the most sophisticated electronic navigational, control and attack aids ensure outstanding effectiveness in all operational roles.

The Harrier is the only operational aircraft in the world able to take off vertically, or with only a very short run, thus making it completely independent of prepared air-strips.

Despite this helicopter-like capability, the Harrier can attain speeds in excess of Mach 1, has an endurance of more than 7 hours and has already flown with external stores of 3630 kg (8000 lb) and will shortly be cleared to 4540 kg (10 000 lb).

A full range of the latest electronic aids, including INAS (inertial navigation and attack system), ensure strike effectiveness under the most difficult conditions.

The T2 two-seater Harrier in service with the Royal Air Force has a dual fighter/trainer role.

A Harrier aircraft established the Central New York—Central London time of 5 hours 31 minutes 10 seconds, taking off and landing from building sites in the centre of both cities.

Pictured is a Harrier in US Marine Corps markings carrying external stores of 3630 kg (8000 lb).

The Hunter, although one of the first jet fighters to reach operational service, has undergone constant development and still represents one of the most effective ground-attack and general-service fighters available today.

In service with the Royal Air Force and twelve other air forces in all parts of the world, the Hunter can deliver a considerable load of varied weapons at near-sonic speed over a wide radius.

The basic Hunter is available in many specialised versions, including two-seat operational trainer, single-seat reconnaissance fighter, interceptor and ground-attack fighter. Reliability and safety have made it one of the most popular aircraft with pilots everywhere.

Buccaneer, Harrier, Hunter

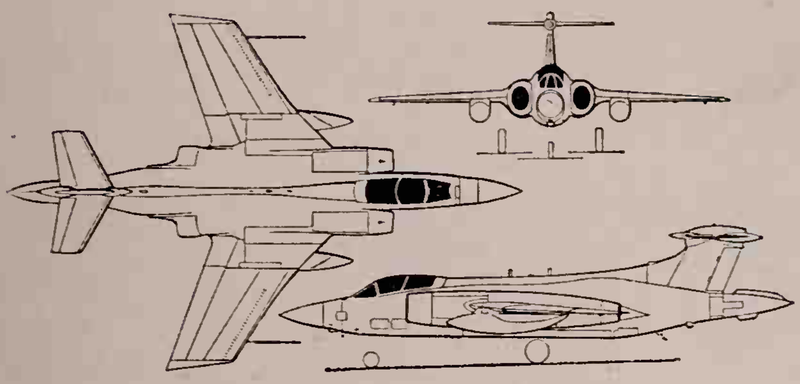
Low-level strike and ground-attack aircraft

Hawker Siddeley Aviation is one of the largest aircraft manufacturing company outside the USA. Its products cover the entire range of fixed-wing aircraft from civil and military trainers to strategic bombers and jet airliners.

Hawker Siddeley Aviation is part of the Hawker Siddeley Group, one of the largest industrial organisations in the world with branches in Australia, New Zealand, Canada, the USA, South Africa, Argentina, India and Pakistan. The Group has 94 000 employees and a turnover exceeding £1 million a day.

In addition to aviation, manufacture extends to missiles and aerospace equipment, diesel engines, electric power, general engineering and metals.

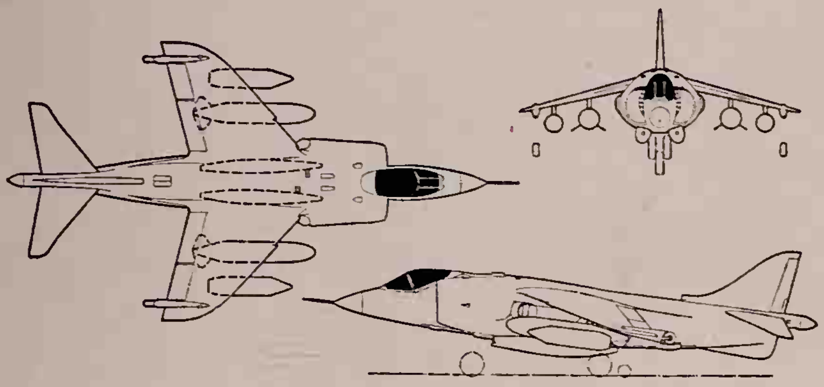
Buccaneer S Mk 2 low-level strike aircraft



Power plant: two Rolls-Royce Spey turbofan engines
Span: 13·4 m (44 ft 0 in) spread; 6·0 m (19 ft 11 in) folded
Length: 19·3 m (63 ft 5 in) spread; 15·8 m (51 ft 10 in) folded
Height: 4·95 m (16 ft 3 in)
Gross wing area: 47·8 m^2 (515 ft^2)
Aspect ratio: 3·76
Normal crew: pilot and observer
Typical war loads: Martel, Bullpup or AS 30 air-to-ground missiles on wing pylons; 68 mm or 2 in rocket pods on wing pylons; 4 × 450 kg (1000 lb) bombs in bomb bay, 3 × 450 kg (1000 lb) bombs on each of four wing pylons; day/night photo reconnaissance pack. Total war load 7250 kg (16 000 lb)
Weight and performance: details not released but speed is high subsonic
Range at max all-up weight: an unrefuelled non-stop flight of 3700 km (2300 miles) including a low-level attack has been announced by the Royal Navy (Buccaneer S Mk 2)
Max endurance: a non-stop flight of nine hours with two in-flight refuellings has been announced by the South African Air Force (Buccaneer S Mk 50)

The Buccaneer is in production for the Royal Air Force

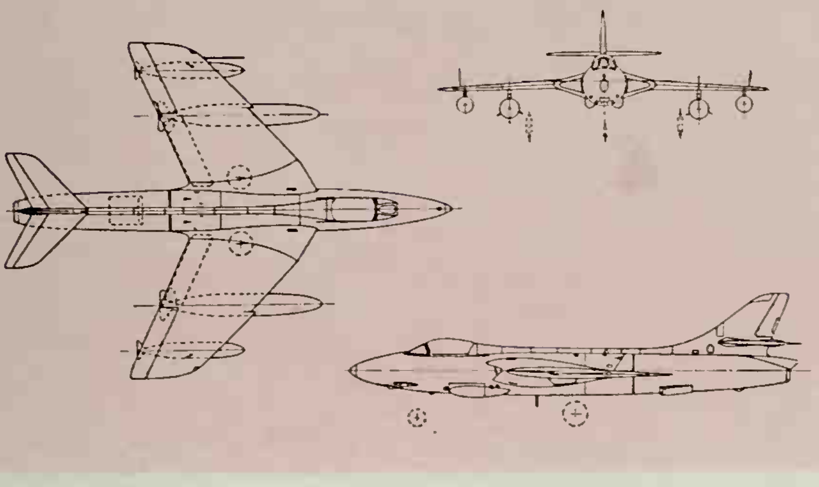
Harrier GR Mk 1 V/STOL fighter



Power plant: one Rolls-Royce Bristol Pegasus 101 vectored-thrust turbofan engine
Max static thrust: 8620 kg (19 000 lb)
Span: 7·70 m (25 ft 3 in)
Length: 14·12 m (46 ft 4 in)
Height: 3·35 m (11 ft)
Gross wing area: 18·67 m^2 (201 ft^2)
Normal crew: pilot
Weight: 5440 kg (12 000 lb) empty; 7260 kg (16 000 lb) max hover; in excess of 9980 kg (22 000 lb) gross
Speed: transonic (no details available)
Ferry range: 3700 km (2000 nm)
War load: in excess of 2268 kg (5000 lb) including two 30 mm Aden guns
External fuel tanks: 455 litres (100 gal) combat; 1500 litres (330 gal) ferry

The Harrier is in operation with and in production for the Royal Air Force and in production for the United States Marine Corps

Hunter FGA 9 and FR 10



Power plant: one Rolls-Royce Avon Mk 207 turbojet engine
Static thrust: 4540 kg (10 000 lb)
Span: 10·26 m (33 ft 8 in)
Length: 13·98 m (45 ft 10½ in)
Height: 4·0 m (13 ft 2 in)
Gross wing area: 32·42 m^2 (349 ft^2)
Normal crew: pilot
Weight: 9980 kg (22 000 lb) gross
Max speed: 0·95 Mach

Refurbished Hunters are still in great demand throughout the world

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Richmond Road, Kingston upon Thames, Surrey, England
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Able to operate from rough airfields, requiring only simple maintenance and giving dependable service at comparatively low cost, the HS 748 is ideal for military operation.

The unobstructed layout of the main fuselage allows it to be quickly adapted from airborne stateroom to cargo transport.

Internal starting and hydraulically operated airstairs can be provided. Combined with the high landing weight of 18 824 kg (41 500 lb) which enables the HS 748 to carry its own fuel for several short stages, the aircraft can operate independently of ground support.

The Series 2A has a greater load-carrying capacity, requires a shorter runway, has even more extended inspection periods (500 hours instead of 250 hours) and has a higher rate of climb than the original version.

The Andover is the fully militarised version of the highly successful HS 748. While retaining full cabin pressurisation, the Andover has been adapted to transport relatively bulky and heavy loads and will accept floor loadings of up to 976 kg/m^2 (200 lb/ft^2).

With a maximum all-up weight of 22 680 kg (50 000 lb), the Andover can lift a payload of up to 6800 kg (15 000 lb) with a take-off run of less than 400 m (1300 ft).

The rear loading doors form a ramp which, coupled with the unique kneeling undercarriage, gives direct ground-loading access to the entire hold. A side door is also provided.

Twin low-pressure tyres all round, a steerable nose wheel and other features enable the Andover to use unprepared air strips.

The Argosy was designed primarily as a cargo transport and is used by the RAF in the medium-range tactical support role. With its Rolamat cargo handling system, the full cargo of up to 13 tons can be loaded and unloaded in little more than ten minutes.

The cargo area is designed to take six standard military pallets 2·55 × 2·24 m (108 × 88 in), with the cargo deck being at normal truck height.

At the same time, the aircraft has full pressurisation and air conditioning, enabling it to carry 84 men in high-density seating, or 54 paratroops with full kit.

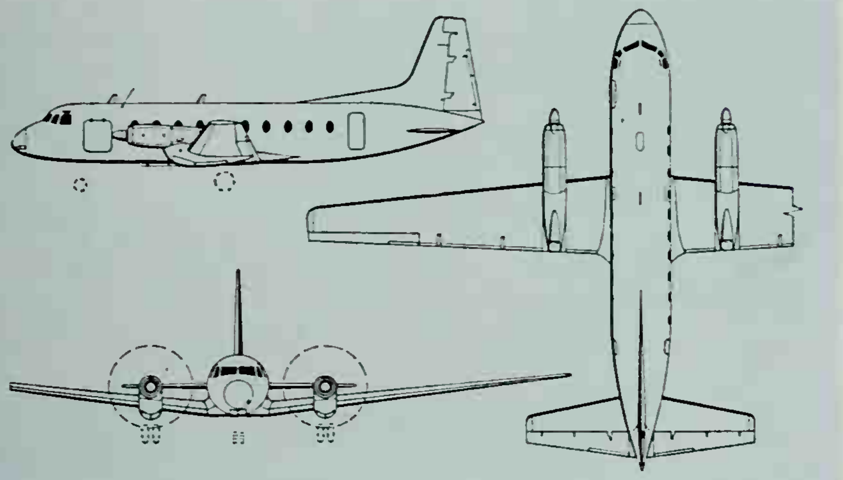
The four Rolls-Royce Dart engines have a time between overhaul of well over 2000 hours, enabling the Argosy to give sustained service over long periods.

HS 748, Andover, Argosy

Transport and support aircraft

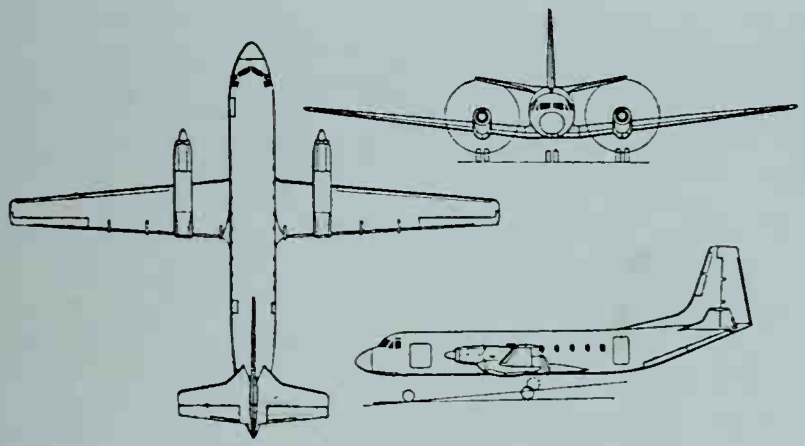
These three aircraft in their many available versions completely meet the need for the fast, safe and cost-effective movement of personnel and stores in any modern fighting force.

HS 748 Series 2A feeder airliner



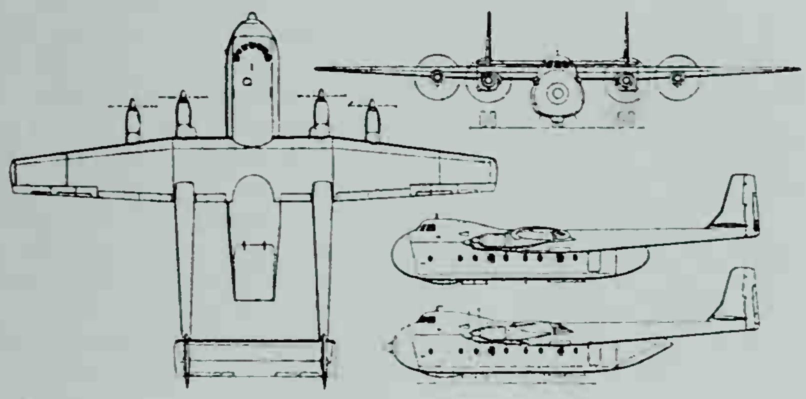
Power plant: two Rolls-Royce Dart RDa.7 Mk 532 engines
Effective shaft horsepower: 2230 each engine
Span: 30·02 m (98 ft 6 in)
Length: 20·42 m (67 ft 0 in)
Height: 7·58 m (24 ft 10 in)
Gross wing area: 75·35 m^2 (810·75 ft^2)
Max wing loading: 267 kg/m^2 (54·9 lb/ft^2)
Aspect ratio: 11·967
Normal crew: pilot and co-pilot
Passenger accommodation: 48 (typical), 58 (high-density) plus 9·54 m^3 (337 ft^3) cargo capacity
Cargo hold (freight version): 14·30 × 1·92 × 2·46 m = 54·86 m^3 (46 ft 6 in × 6 ft 4 in × 8 ft 1 in = 1936 ft^3)
Max all-up weight: 20 183 kg (44 495 lb)
Max payload: 5300 kg (11 700 lb)
Typical cruise: 453 km/h at 4600 m (245 knots at 15 000 ft) ISA
Typical range: 1650 km (890 nm) with 4540 kg (10 000 lb) payload
Take-off balanced field length (at max AUW): 1230 m (4050 ft)
Landing distance from 15 m (50 ft); 1010 m (3310 ft)

Andover C Mk 1 military transport



Power plant: two Rolls-Royce Dart RDa.12 engines
Effective shaft horsepower: 3245 each engine
Span: 29·95 m (98 ft 3 in)
Length: 23·77 m (78 ft 0 in)
Height: 9·17 m (30 ft 1 in)
Gross wing area: 77·2 m^2 (831·4 ft^2)
Max wing loading: 293·8 kg/m^2 (60·1 lb/ft^2)
Aspect ratio: 11·61
Normal crew: pilot and co-pilot (radio operator/navigator optional)
Typical loads: 56–58 troops, 40 paratroops, 24 stretcher cases with nursing team, vehicles, 6963 kg (15 350 lb) freight
Cargo hold: 14·11 × 1·91 × 2·47 m (46 ft 3 in × 6 ft 3 in × 8 ft 1 in)
Max all-up weight: 22 680 kg (50 000 lb)
Typical cruise: 416 km/h at 6100 m (225 knots at 20 000 ft) ISA
Range at max all-up weight: 1850 km (1000 nm), 5% reserve
Max endurance: 7·5 hours

Argosy Mk 660 military transport



Power plant: four Rolls-Royce Dart RDa.8 Mk 101 engines
Effective shaft horsepower: 2680 each engine
Span: 35·05 m (115 ft 0 in)
Length over nose radome: 27·13 m (89 ft 0 in)
Height: 8·23 m (27 ft 0 in)
Gross wing area: 135·45 m^2 (1458 ft^2)
Max wing loading: 351 kg/m^2 (72·0 lb/ft^2)
Aspect ratio: 9·07
Normal crew: pilot, co-pilot, navigator, flight engineer
Cargo hold: 14·27 × 2·59 × 2·64 m (46 ft 10 in × 8 ft 6 in × 8 ft 8 in)
Typical loads: palletised freight, AFVs, 54 paratroops, 69 troops, 48 stretcher cases with nursing team
Max all-up weight: 47 610 kg (105 000 lb)
Typical cruise: 433 km/h at 6100 m (234 knots at 20 000 ft) ISA
Range at max all-up weight: 5230 km (2830 nm), 13% reserve
Max endurance: 10 hours

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The Nimrod is the world's first jet-powered maritime reconnaissance aircraft and utilises some of the airframe design and detail developed for the Comet 4C civil airliner. The four Rolls-Royce Spey turbofan powerplants give good specific fuel consumption and enable long-range low-level missions to be flown. In the patrol phase at average search weights loiter time can be extended by shutting down two engines without sacrificing safety.

The high speed of the Nimrod renders it ideal for dealing with the rapidly changing tactical pattern of naval warfare involving modern high-speed submarine and surface vessels. The spacious cabin accommodates all the electronic equipment and operators required to meet naval reconnaissance requirements. A wide range of stores can be carried in the large fuselage weapons bay and missiles can be carried on wing pylons.

The Shackleton is a mid-wing monoplane designed for long-range anti-submarine and reconnaissance patrols under all climatic conditions. Normally a crew of ten is carried but additional personnel can be accommodated without difficulty.

Equipped with the latest search equipment and powerful offensive armament, the Shackleton can also carry a large and varied load of detection equipment and anti-submarine weapons.

Particular attention has been paid to requirements which demand long periods of operation at low altitude and low speed, and interiors have been furnished and equipped to meet stringent specifications. Crew comfort is of the highest standard and includes such items as a full air-conditioning system, galley and wardroom.

The HS 125 six- to twelve-seat jet transport aircraft is in service with a number of the world's air forces. A navigational trainer version known as the Dominie is also in service with the RAF. The HS 125 offers high speed, flexibility and reliability in service with low operating costs, simple maintenance and the ability to operate from unpaved strips.

In the crew trainer version the large cabin provides ample space for up to four students and a wide range of electronic equipment, which enables instructors to give weapon system and navigation training under realistic operational conditions.

The wide operating capability of the HS 125 renders it suitable for many other roles, including advanced pilot trainer, mobile headquarters, personnel transport, casualty evacuation, radar calibration, photographic reconnaissance and courier services.

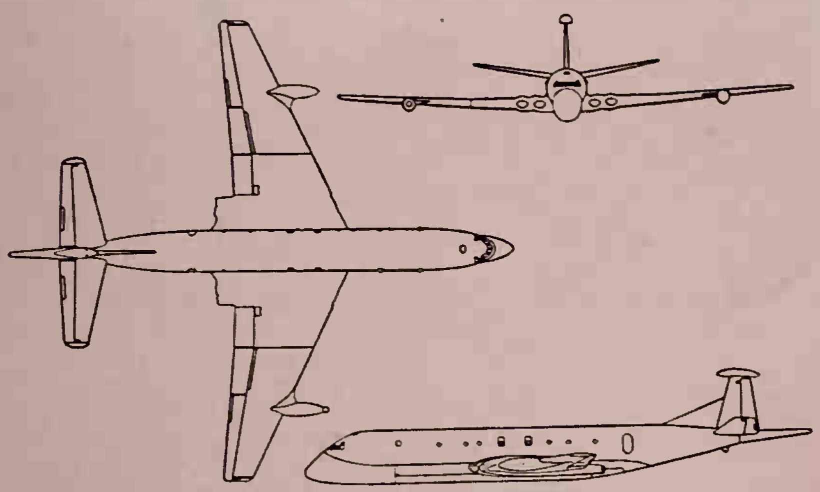
The Rolls-Royce Bristol Viper gas turbine engines of the HS 125 have over $1\frac{1}{2}$ million flying hours under all conditions and have proved to be reliable in service.

Nimrod, Shackleton, HS 125

for reconnaissance, patrol and training

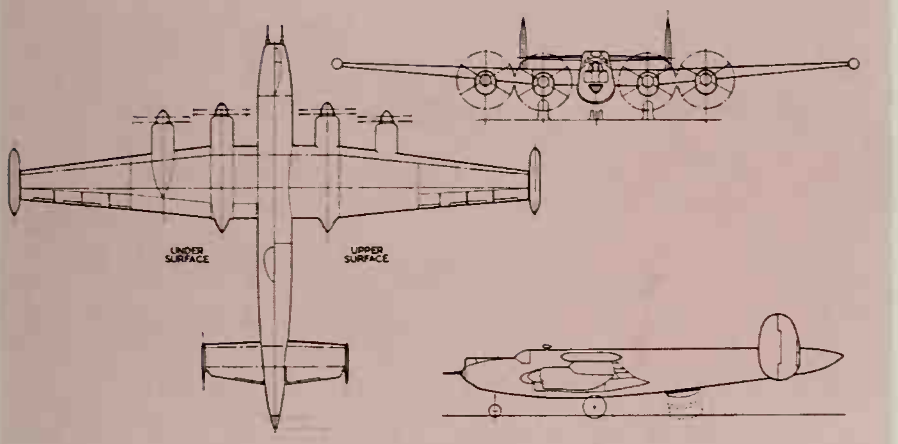
Dependability, endurance and economy in operation are the outstanding features of these aircraft—essential qualities for all reconnaissance and long-range patrol work, under all types of conditions anywhere in the world.

Nimrod MR 1 maritime reconnaissance jet



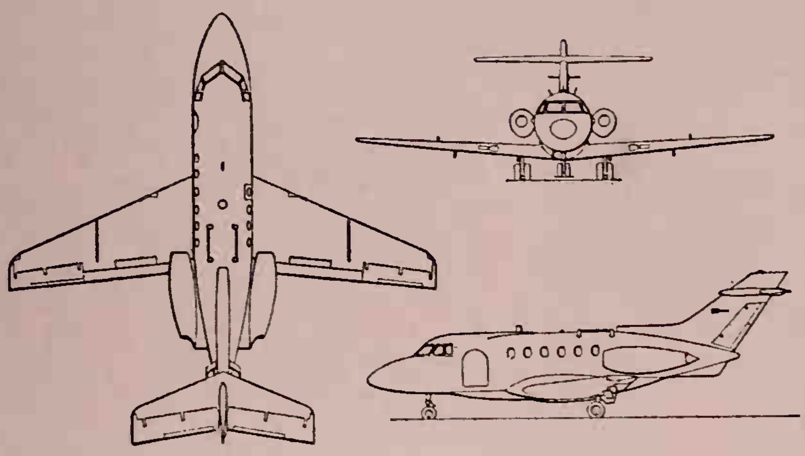
Power plant: four Rolls-Royce Spey turbofan engines
Span: 34·99 m (114 ft 10 in)
Length: 38·63 m (126 ft 9 in)
Height: 9·04 m (29 ft 8 in)
Normal crew: 11
No further details released

Shackleton MR 3 long-range patrol aircraft



Power plant: four Rolls-Royce Griffon piston engines
two Rolls-Royce Bristol Viper turbojet engines
Effective shaft horsepower: 2450 each Griffon engine
Thrust: 1134 kg (2500 lb) each Viper engine
Span: 36·52 m (119 ft 10 in)
Length: 28·19 m (92 ft 6 in)
Height: 7·11 m (23 ft 4 in)
Normal crew: 10
Weight (empty): 26 220 kg (57 800 lb)
Weight (loaded): 45 400 kg (100 000 lb)
Service ceiling: 5850 m (19 200 ft)
Cruising speed: 405 km/h (220 knots)
Armament: two nose-mounted 20 mm guns, full range of anti-submarine warfare weapons

HS 125 jet transport and navigation trainer



Power plant: two Rolls-Royce Bristol Viper 522 engines
Thrust: 1525 kg (3360 lb) each engine
Span: 14·32 m (47 ft 0 in)
Length: 14·42 m (47 ft 5 in)
Height: 5·03 m (16 ft 6 in)
Gross wing area: 32·8 m^2 (353 ft^2)
Max wing loading: 314 kg/m^2 (65·9 lb/ft^2)
Aspect ratio: 6·25
Normal crew of navigation trainer: pilot, instructor plus 2, 3 or 4 students
Max all-up weight: 10 569 kg (23 300 lb)
Max landing weight: 9072 kg (20 000 lb)
Max zero fuel weight: 6441 kg (14 200 lb)
Typical cruise: 817 km/h at 9449 m (441 knots at 31 000 ft) ISA
Range at max all-up weight: 2697 km (1455 nm)
Max endurance: 4·33 hours with 20% reserves

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The Vampire T11 all-purpose jet trainer was developed from the Vampire single-seat fighter and the two-seat night fighter.

The object behind the design was to provide the widest variation of training duties, while retaining the simplicity and good handling characteristics of the original.

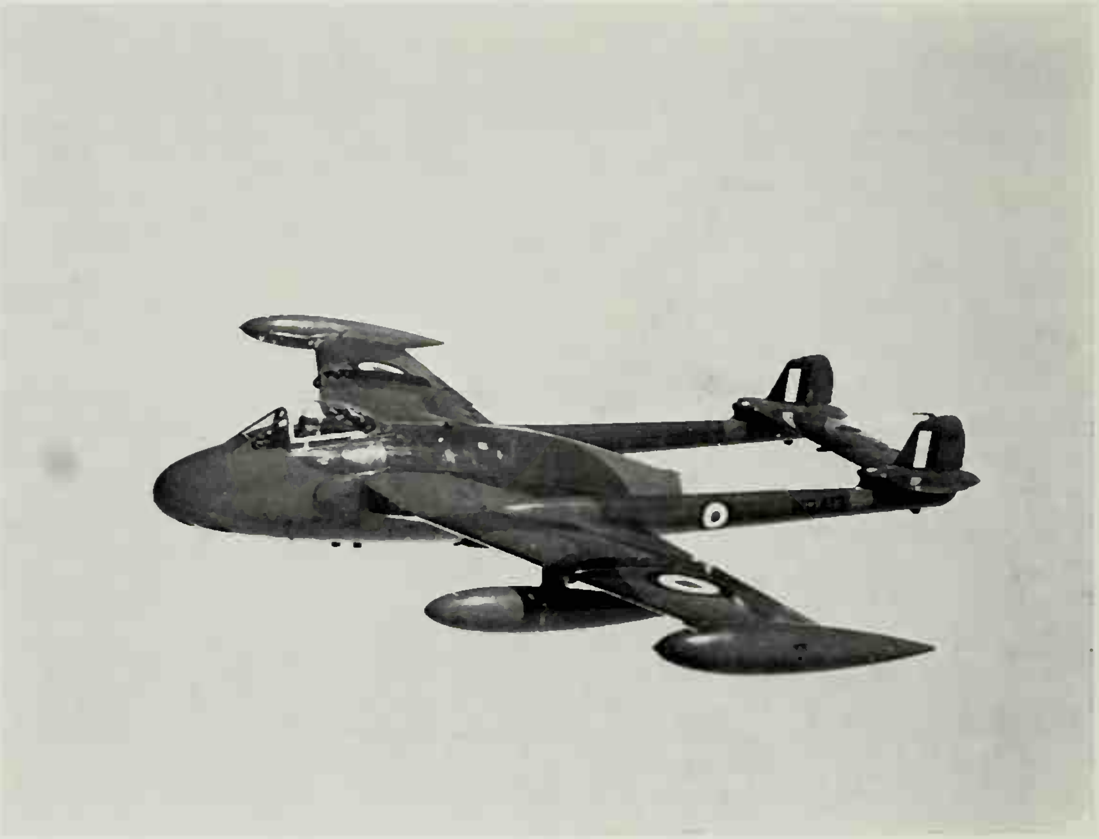
Powered by a Goblin 3 turbo-jet engine, the Vampire T11 can carry a variety of underwing stores together with four 20 mm cannon mounted within the fuselage.

More than 800 Vampire trainers were built and saw service with the Royal Air Force and some twenty other air forces.

The Venom FB4 single-seat fighter was a development of Vampire and earlier Venom aircraft. Powered by a Ghost 103 turbo-jet engine, the FB4 possessed characteristics which enabled it to fulfil the double role of ground-attack fighter and high-altitude interception, by virtue of its moderate wing loading, low all-up weight, high degree of manoeuvrability and an outstanding rate of climb. More than 1143 Venoms were built and saw service with many air forces in all parts of the world.

The Venom was also available in NF3 form as an all-weather interceptor designed to meet the demand for a high-performance fighter equipped with modern search and interception radar, capable of operating in all weather conditions by day or night.

With power-operated controls both versions have excellent manoeuvrability characteristics at all heights and moderate landing speeds thus ensuring flexibility of operation from airfields of limited dimensions.



XN684
ROYAL NAVY
XN684

The Sea Vixen FAW 2 is an all-weather weapon system carrying a crew of two in a pressurised cabin. It is powered by two Avon Mk 208 turbo-jet engines developing 10 200 kg (22 500 lb) combined static thrust at sea level. In addition to a wide variety of external stores, including guided weapons (Red Top and/or Firestreak), rockets and bombs the Sea Vixen can carry drop tanks, a photographic reconnaissance pod, flares or a Palouste starter.

The numerous operational load configurations make the aircraft extremely versatile. It is a potent all-weather interceptor and sea/ground-attack aircraft with an excellent performance when used in the photographic reconnaissance role.

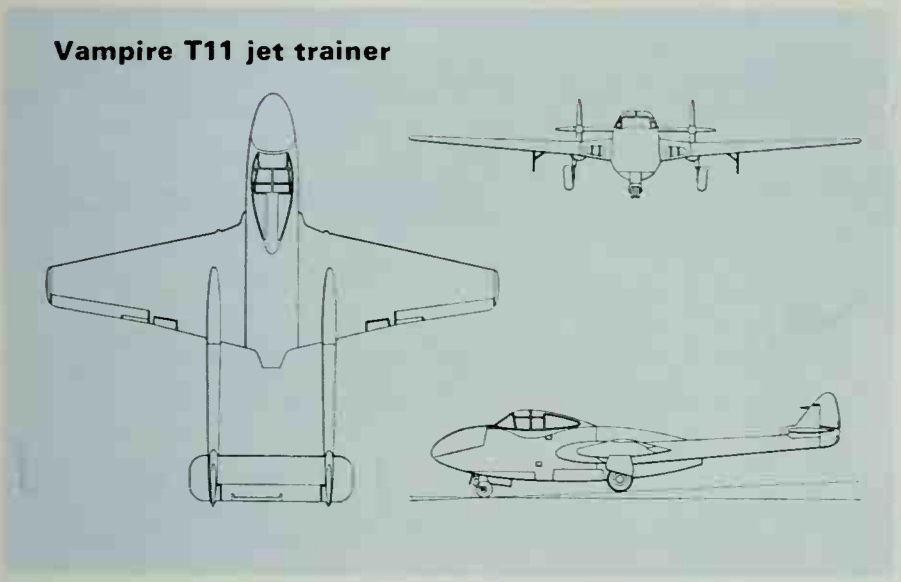
The Sea Vixen FAW 2 can be used for flight refuelling as a receiver or as a tanker and its ability to carry a Palouste starter facilitates ferrying and rapid operational readiness after redeployment.

Vampire, Venom, Vixen

strike, reconnaissance and trainer aircraft

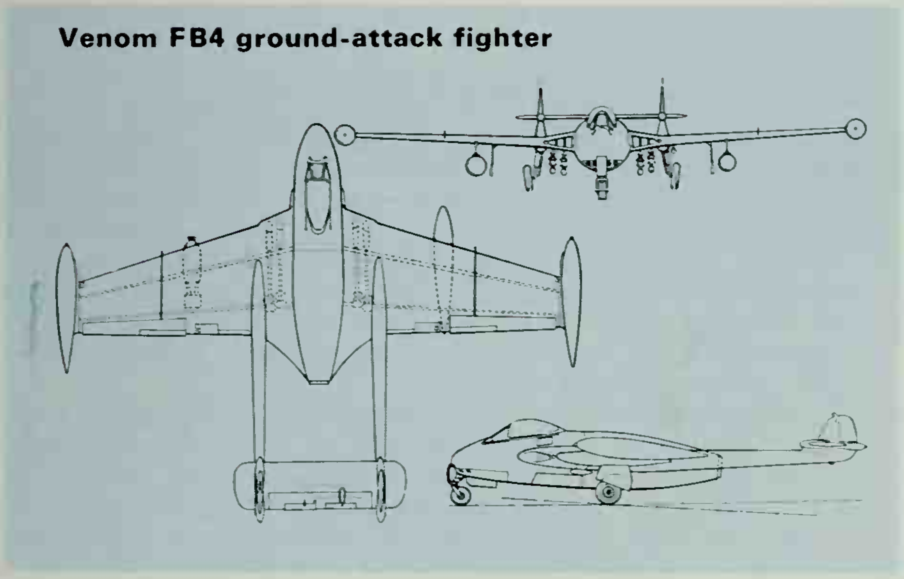
These aircraft of proven performance constitute an effective striking and local reconnaissance force, while providing ideal training facilities for pilots and crew under operating environments typical of aerial warfare.

Vampire T11 jet trainer



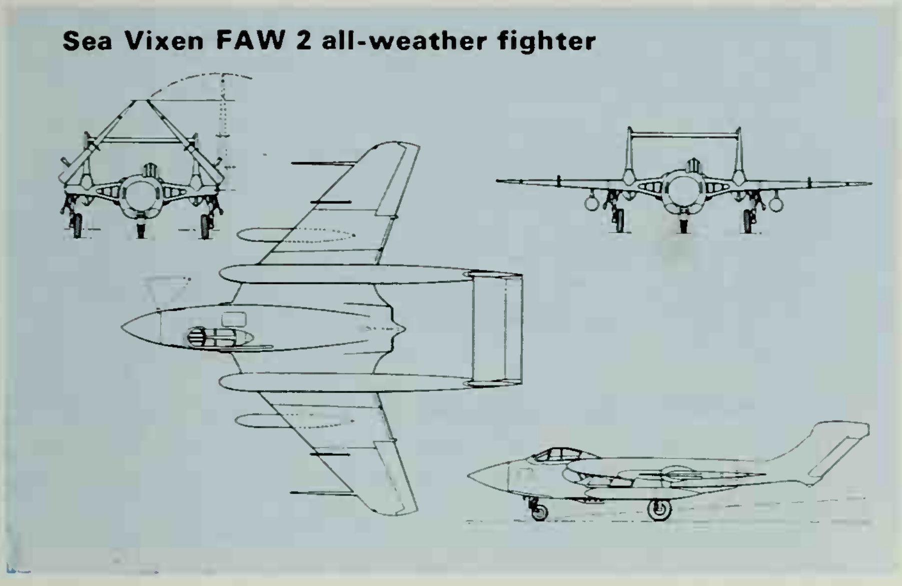
Power plant: Rolls-Royce Bristol (DH) Goblin 35 jet engine
Static thrust: 1565 kg (3450 lb)
Span: 11·58 m (38 ft 0 in)
Length: 10·49 m (34 ft 5 in)
Height: 2·00 m (6 ft 7 in)
Gross wing area: 24·25 m² (261 ft²)
Thickness/chord ratio: 14%
Normal crew: two
Max all-up weight: 6170 kg (13 610 lb)
Zero-fuel weight: 3815 kg (8410 lb)
Fuel capacity (internal): 1500 litres (330 gal)
Max wing loading: 254·85 kg/m² (52·2 lb/ft²)
Max level speed at sea level: 844 km/h (456 knots)
Max permissible level speed: 870 km/h (470 knots) = 0·71 Mach
Still-air range at sea level: 480 km (260 nm) from internal fuel
Still-air range at 12 200 m (40 000 ft): 1020 km (550 nm) from internal fuel
Endurance at sea level: 1·80 hours from internal fuel
Typical war load: two 20 mm cannon plus 8 rocket projectiles and two 227 kg (500 lb) bombs, or two 454 kg (1000 lb) bombs, or two 454-litre (100-gal) drop tanks

Venom FB4 ground-attack fighter



Power plant: Rolls-Royce Bristol (DH) Ghost 103 turbo-jet engine
Static thrust: 2200 kg (4850 lb)
Span: 12·72 m (41 ft 9 in) with tip tanks
Length: 10·06 m (33 ft 0 in)
Height: 2·00 m (6 ft 7 in)
Gross wing area: 25·92 m² (279 ft²)
Thickness/chord ratio: 10%
Normal crew: pilot
All-up weight without external equipment: 5450 kg (12 040 lb)
All-up weight with tip tanks: 6100 kg (13 450 lb)
Wing loading: 269·51 kg/m² (55·2 lb/ft²)
Max level speed at sea level: 965 km/h (523 knots) = 0·79 Mach
Still-air range at sea level: 500 km (270 nm) with 1514 litres (333 gal) fuel
Still-air range at 12 200 m (40 000 ft): 1460 km (790 nm) with 1514 litres (333 gal) fuel
Typical war load: four 20 mm cannon (fixed) plus two 454 kg (1000 lb) bombs, or two 227 kg (500 lb) bombs plus 8 rocket projectiles, or two 364-litre (80-gal) drop tanks on pylons

Sea Vixen FAW 2 all-weather fighter



Power plant: two Rolls-Royce Avon 208 turbo-jet engines
Static thrust: 5100 kg (11 250 lb) each engine
Span: 15·24 m (50 ft 0 in), wings open; 6·78 m (22 ft 3 in), wings folded
Length: 16·33 m (53 ft 7 in), overall; 15.30 m (50 ft 2½ in), nose folded
Height: 3·50 m (11 ft 6 in) to top of tail; 5·66 m (18 ft 7 in), wings vertical; 4·29 m (14 ft 11½ in), wings folded
Gross wing area: 60·2 m² (648 ft²)
Sweep-back (¼ chord): 40°
Aspect ratio: 3·86
Normal crew: pilot, observer
Max all-up weight: 20 960 kg (45 123 lb)
Max landing weight: 15 880 kg (35 000 lb)
Zero-fuel weight: 14 380 kg (31 715 lb) with 4 Red Top missiles and two 900-litre (200-gal) drop tanks
Typical cruise: 0·45 Mach at low level, 0·80 Mach at high altitude
Ferry range: 2590 km (1400 nm)
Typical war load: Hawker Siddeley Red Top or Firestreak guided missiles, high-explosive bombs and 24-cell rocket launchers

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Tactical role

This role requires flexibility of operation over a series of missions, ground attack, interdiction, armed reconnaissance, etc. and thus a high degree of interchangeability between range and payload. This in turn demands a large internal fuel volume and a maximum store station weight/capacity interchange.

Performance in typical missions is as follows:

	Internal fuel		*External fuel*	
	km	Nautical miles	km	Nautical miles
Lo-Lo-Lo (radius) ..	650	350	850	460
Hi-Lo-Hi (radius) ..	1250	675	1650	800
Ferry range ..	—	—	4500	2450

with a take-off distance to 15m (50ft) of 716m (2350ft) at the normal take-off weight.

Trainer role

The Jaguar trainer meets the requirement to train pilots for the most advanced first-line aircraft with modern weapons at minimum cost. It has the capability to sustain supersonic flight for significant periods to match the fuel and navigation management problems of the operational types. It also has the relevant weapon and system characteristics to meet the needs of all but the final phase of operational training.

The missions which can be flown at high altitude vary from 3h subsonic to 1¾h with high supersonic cruise, while at low level the sortie duration is 1½h including 20min at M = 0·9.

Weapon carriage

Jaguar can carry a maximum weapon load of 4540kg (10 000lb) on one fuselage and four underwing pylons. Weapons up to a unit weight of 900kg (2000lb) can be carried.

This allows the carriage of:

Air-to-surface guided weapons such as AS.30 and AS.37 Martel A.R.
1000lb bombs free-fall or retarded
470kg bombs free-fall or retarded
500lb bombs free-fall or retarded
250kg bombs
250lb bombs
125kg bombs
SNEB rocket launchers
Flares
Drop tanks
Recce pods

Studies by BAC and Breguet have also shown that Sidewinder, special extra-size fuselage recce and fuel pods, and mini-gun or Vulcan gun pods could be accommodated.

Twin 30mm cannons are mounted in the fuselage. These are retained for all missions.

Avionics

As the environment in which tactical aeroplanes must operate becomes progressively more severe in terms of sophistication of ground defences, so it becomes increasingly necessary to ensure that none of the time spent at risk is wasted. Thus navigation and weapon delivery must both be upgraded. This in turn results in a greater dependence on avionics, and in an aeroplane which has to be operated near the battlefields with minimum support every step must be taken to ensure that the necessary electronic aids are highly reliable and rugged.

To meet this situation and to ensure that the navigation and attack system will continue to match the changing operational needs throughout the 1970s, the avionics system of the British 'S' and 'B' versions of Jaguar is based on an inertia platform and digital computer. The computer program can easily be changed to accept new weapons and new operating conditions.

Other versions are available, as developed for the French Air Force and French Navy, and these vary from the most simple flight data standard to a high-quality doppler/gyro system. All variants include Tacan radio navigation.

Fatigue life

A fatigue life of 3000 flying hours is required of the single-seat Jaguar. In the training version this requirement is increased to 6000h.

Fatigue proving will be based on a sortie breakdown which defines the time spent in low-altitude subsonic flight, medium-altitude flight, high-altitude supersonic flight, ferry flight, and so on.

Maintainability and reliability

The basic target in this area is that no more than 10·5 manhours should be necessary per flying hour, assuming the aircraft flies five one-hour sorties daily.

A maintainability group worked closely with the design staffs on the assessment of the maintenance process for Jaguar, and the result of the assessment has guided the choice and installation of all systems and equipment requiring frequent attention.

The requirement here is twofold. If a failure is defined as a defect which causes the mission to be abandoned or curtailed, the failure rate must be not more than 51·3 failures per 1000 flying hours—an MTBF (mean time between failures) of roughly 20h. Secondly, taking a defect as a malfunction requiring unscheduled servicing, the requirement here is that the defect rate must be not more than 300 defects per 1000 flying hours.

Jaguar

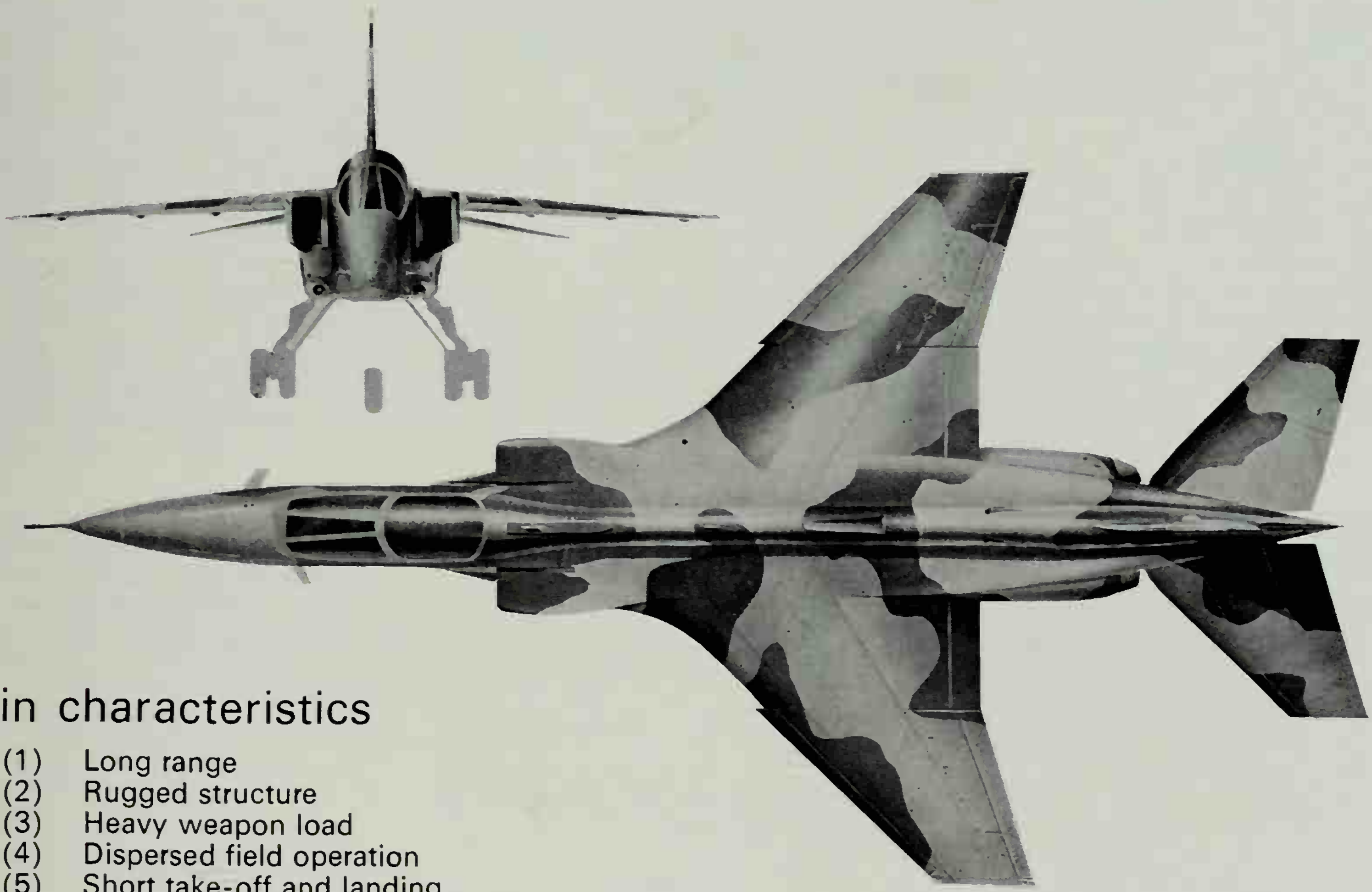
tactical support and operational training aircraft

Jaguar is the new twin-engined dual-role tactical support and high-performance trainer aircraft coming into service with the Royal Air Force in 1972, and the French Air Force in 1971. The French Navy will also have a tactical version with provision for carrier operation. Initial orders have been received for 400 aircraft—200 for Britain and 200 for France.

The two basic roles make similar demands; the only major difference between the tactical aircraft and the trainer is the provision of a second cockpit for the instructor in the trainer version.

Jaguar's performance and equipment match the demands of the 1970s. In particular the British navigation system is based on a digital computing system, so that changes in operation and weapons can be accommodated by changing the system programme.

The flight test programme involving eight prototype aircraft is well under way.



Main characteristics

(1) Long range
(2) Rugged structure
(3) Heavy weapon load
(4) Dispersed field operation
(5) Short take-off and landing
(6) Supersonic capability at all altitudes
(7) High manoeuvrability

Additional features are:

Twin engines plus duplicated systems and armour protection as part of design for survival.

A high degree of safety in the take-off and landing phase, particularly vital in the trainer role.

A low gust response to provide an acceptable environment for the crew at high speed and low altitudes.

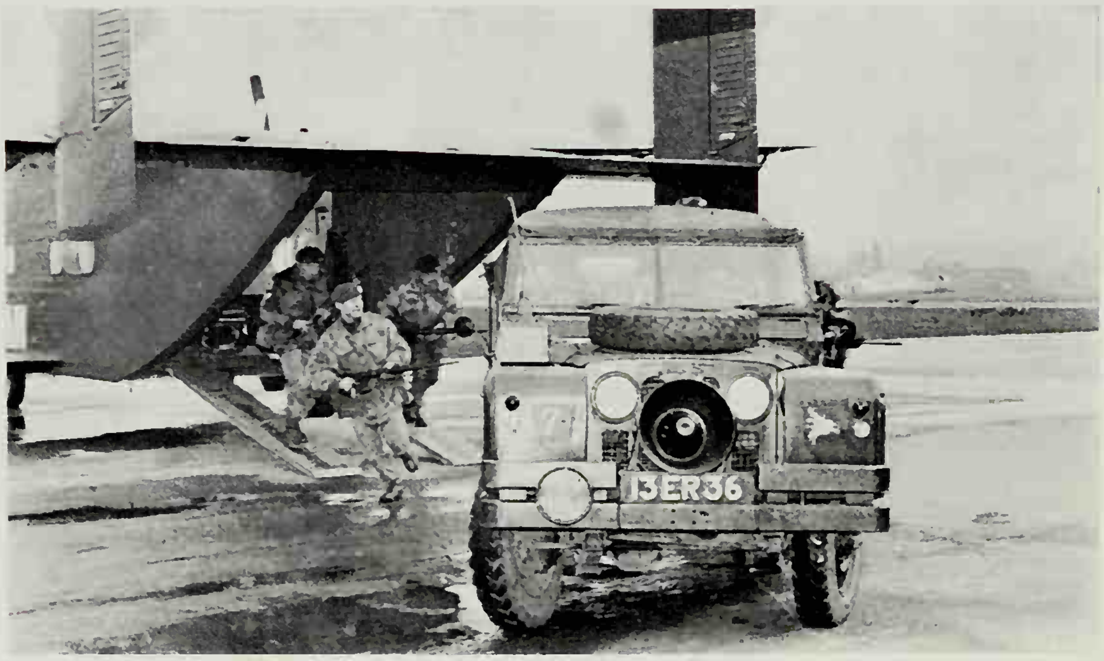
Wing span 8·488m (27·86ft)
Length: single seat 15·520m (50·91ft)
two seat 16·420m (53·87ft)
Height 4.640m (15·22ft)
Aspect ratio 3·00
Wing sweep 40°
Ultimate load factor 12
Normal take-off weight 10 000kg (22 046lb)
Maximum take-off weight 13 500kg (29 762lb)
Weapon load 4500kg (10 000lb)
Engine thrust: dry 2000kg (4400lb)
with reheat 3000kg (6600lb)

The versions available and their equipment standards are as follows:

No. of seats	Role	Version	Service	Special-to-type features
1	*Tactical support	A	French Air Force	Doppler/gyro platform navigation system
	*Tactical support	S	Royal Air Force	Inertial navigation/attack system with head-up display
	*Naval strike	M	French Navy	Naval undercarriage, catapult and arrester gear. Navigation system as 'A' version
	*All three versions have in-flight refuelling capability			
2	Trainer	E	French Air Force	Tacan/gyro platform navigation system
	Trainer	B	Royal Air Force	Inertial navigation/attack system with head-up display

Jaguar is manufactured by the Société Européenne de Production de l Avion Ecole de Combat et Appui Tactique (SEPECAT), a company owned jointly by British Aircraft Corporation and Breguet Aviation. Enquiries should be addressed to the Sales Director of:

S.E.P.E.C.A.T.
c/o British Aircraft Corporation Ltd
Weybridge, Surrey, England
Telephone: Weybridge 45522 Cables: Britair Weybridge Telex: 27111



Skyvan's roomy fuselage and full-width rear loading door easily accommodate a wide range of military equipment including guns and vehicles with their crews

Sixteen fully armed paratroopers can jump in sequence from the rear door sill. Skyvan can carry 22 equipped soldiers

Skyvan

transport aircraft for personnel and equipment

The military Skyvan is a sturdy, versatile aircraft which provides an economic answer to short-haul logistic problems and has already been adopted for service overseas.

Designed primarily to meet the needs of developing countries, which demand the ability to carry awkward, bulky loads while operating from primitive airfields, Skyvan is able to operate from short, unprepared strips in a wide variety of military roles.

As a troop transport Skyvan carries 22 equipped troops in forward-facing seats, assuming a weight of 102kg (225lb) per soldier. The rear door ensures that the troops can disembark with minimum delay. In the military mixed-load configuration the aircraft carries nine troops with a substantial freight load or a full freight load of 2265kg (5000lb). The fuselage easily accommodates a wide range of military equipment including guns and reconnaissance vehicles with their crews.

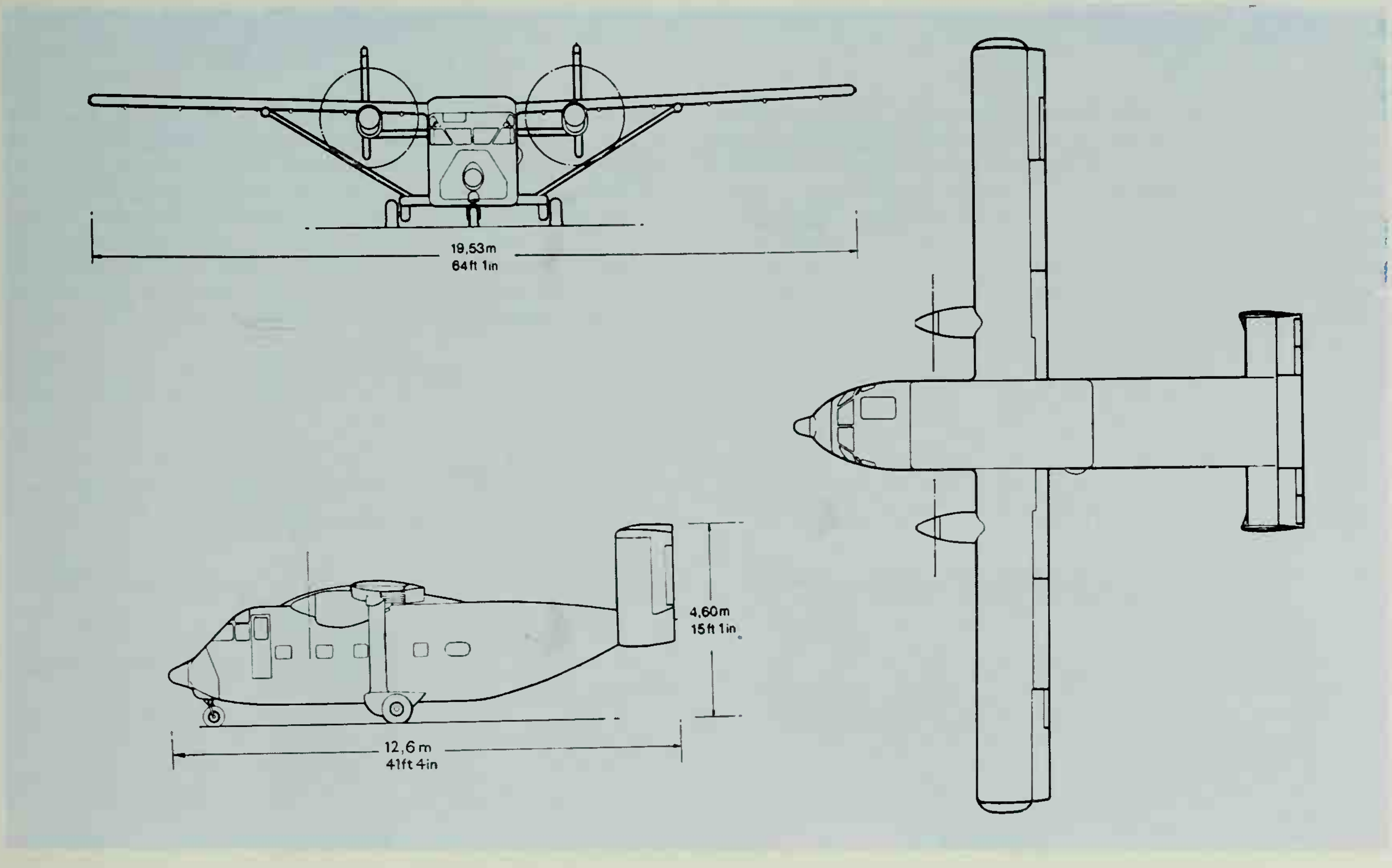
In the casualty evacuation role Skyvan carries up to 12 stretcher cases with two attendants. The 1·98m (6ft 6in) headroom over the whole floor area simplifies the work of medical staff as well as providing added comfort for patients.

Sixteen fully armed paratroopers can be carried and can jump in very rapid sequence from the rear floor sill, controlled by one air dispatcher. The aircraft flies under full control down to indicated air speeds of 120 km/h (65kt). With roller conveyors and extractor parachute systems, palletised loads can also be air-dropped.

With a fuselage cross-section 1·98m (6ft 6in) square, and 5·68m (18ft 7in) long, the Skyvan offers the advantages of a very strong floor, unobstructed capacity and ease of loading. It is powered by two extremely reliable and versatile turboprops, Garrett AiResearch TPE 331-201 engines flat rated at 715shp each, giving a take-off and landing ground run of less than 260m (850ft), up to 325 km/h (175 kt) cruise and excellent low-speed handling qualities.

Skyvan sells at half the price of a helicopter of virtually the same load-carrying capacity and its operating costs are less than half, while its ability to operate from small, rough airstrips enables it to operate from most of the sites which helicopters can use.

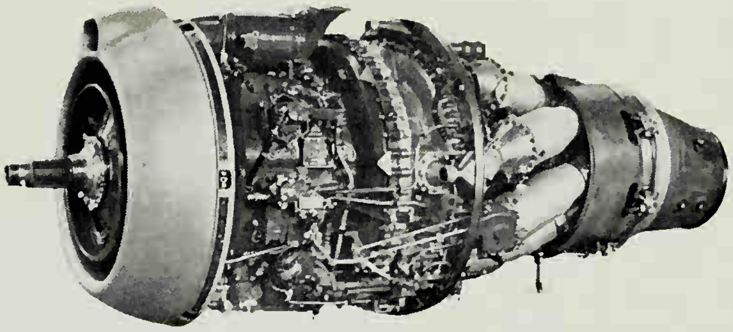
For military purposes the Skyvan can operate at weights up to 6120kg (13 500lb), with a 2265kg (5000lb) payload under normal conditions, and 6580kg (14 500lb) with 2705kg (6000lb) payload under controlled overload conditions.



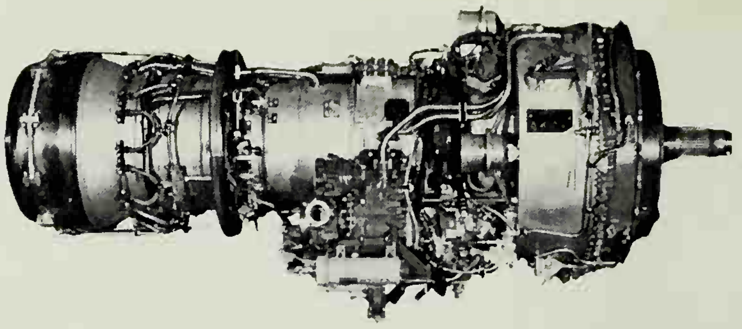
SHORT BROTHERS & HARLAND LIMITED
Skyvan Division
PO Box 241, Queen's Island, Belfast, BT3 9DZ, Northern Ireland
Telephone: Belfast 58444 Cables: Aircraft Belfast Telex: 74688

SHORTS

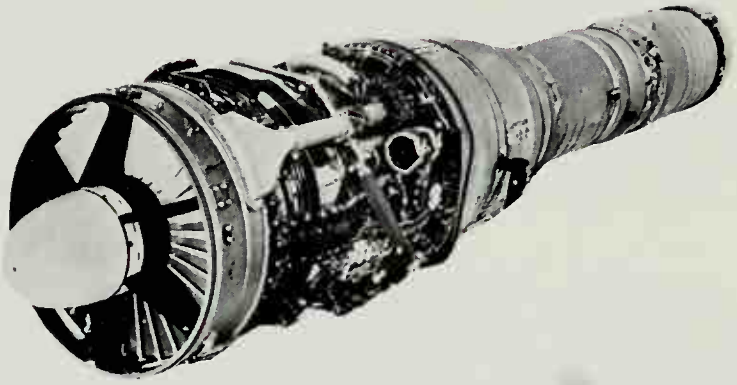
1967
1968
1969
1970



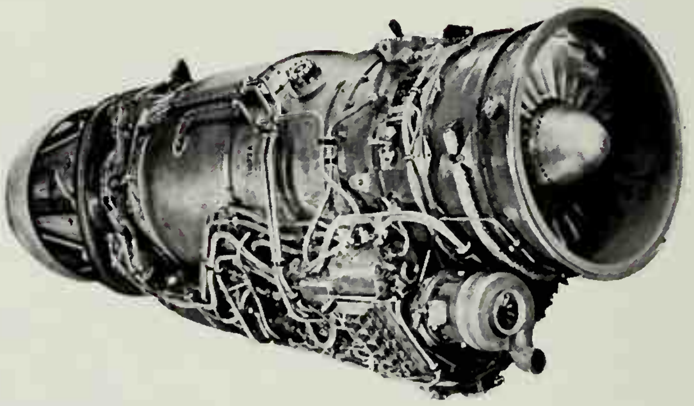
In addition to its world-wide commercial applications, the Rolls-Royce Dart is in service with the Royal Air Force in the Hawker Siddeley Andover and Argosy transports; it also powers the Breguet Alizé anti-submarine aircraft. More than 5000 Dart engines have been produced for twelve aircraft types, and later marks of the engine are still in full-scale production. The operational experience accumulated by this family of engines now totals more than 50 million hours



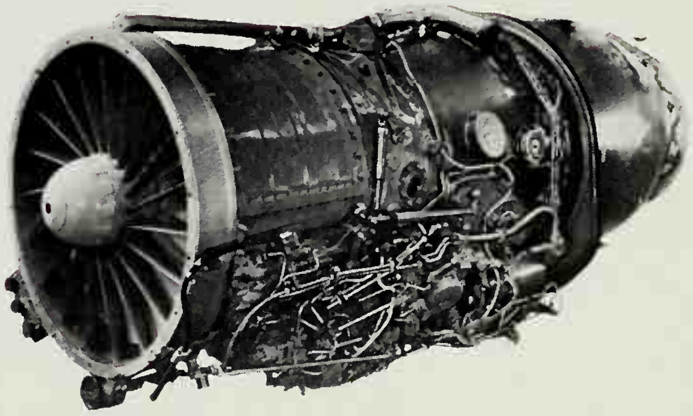
More powerful than the Dart, the Tyne was originally designed for airline operation. However, its economy, high power and good handling made it ideally suited as a powerplant for large military transports, such as the Short Belfast. In 1964 a European consortium was formed, consisting of Hispano Suiza, MAN Turbo, Fabrique Nationale and Rolls-Royce. This group of companies undertakes the joint manufacture of Tyne engines for the Transall C-160 transport and the Breguet Atlantic maritime reconnaissance aircraft for the French and German armed forces



Since entering service in 1951 the Avon has powered military aircraft all over the world. It has been manufactured in greater quantities than any other British gas turbine, and more than six million service hours have been accumulated in bomber, fighter, trainer and transport aircraft. Military versions of the Avon power 27 different types of aircraft throughout the world and are manufactured under licence abroad. The latest application of the Avon is the BAC Lightning supersonic interceptor, the maximum level speed of which considerably exceeds Mach 2



The Rolls-Royce-Turbomeca Adour is a simple, two-shaft turbofan having an integral reheat unit of advanced design. The propulsion unit has been designed for the SEPECAT Jaguar supersonic trainer/strike aircraft and combines high performance at altitude with a good fuel consumption at low level. Rolls-Royce and Turbomeca have formed a joint company, Rolls-Royce-Turbomeca Limited, for the development and manufacture of the Adour for the British and French governments under a 50:50 collaboration agreement



The Spey is the second generation of Rolls-Royce turbofans to enter quantity production, and civil and military engines are being developed to an integrated programme. In addition to its commercial applications, the Spey has been chosen for the McDonnell Phantom strike fighters for the Royal Air Force, the Buccaneer 2 strike aircraft and the Nimrod maritime reconnaissance aircraft. One version of the engine, given the USAF designation TF 41-A-1, is being jointly developed and manufactured by Rolls-Royce and the Allison Division of General Motors

Rolls-Royce has pioneered the design and development of a series of direct-lift engines. The RB 162 is a second-generation liftjet which is used in the German Do 31 V/STOL military transport and in the VAK 191B tactical reconnaissance fighter. A version designated the RB 162-86 has been specified as a booster for the Trident 3B on order for British European Airways. It is on offer for other booster applications, for which its high thrust/weight ratio makes it particularly suitable

Gas turbine engines

for all types of aircraft

Products of the Aero Engine Division of Rolls-Royce include turboprops, turbojets, turbofans and liftjets for a wide range of military aircraft. These engines range from the Dart turboprop and Avon turbojet—both of which have been in service since the early 1950s—through the Spey turbofan to the lightweight RB 162 liftjet and the latest collaborative programmes on the Adour and TF 41 turbofans. The division has also pioneered the development of a family of three-shaft turbofans, including the Trent and RB 211.

The Aero Engine Division has factories in the Midlands of England, in Scotland and several establishments at Barnoldswick, Sunderland and Dundonald in Northern Ireland.

Specifications

Dart RDa 12

Performance	**Power**		**Specific fuel consumption (sea-level static ISA)**	
	cv	tehp	kg/cv/h	lb/tehp/h
Take-off (sea-level static ISA):	3290	3245	0·317	0·708 with water injection
Cruise at 6100 m (20 000 ft) 300 knot:	1642	1620	0·249	0·556

Basic features
Compressor: two-stage centrifugal
Combustion system: seven straight-flow chambers
Turbine: three-stage axial
Reduction gear ratio: 0·0775:1

Weight
Maximum basic dry weight: 629 kg (1387 lb)

Dimensions
Length (without jet pipe): 2527 mm (99·49 in)
Diameter: 963 mm (37·9 in)

Avon Mk 302 C

Performance	**Take-off thrust (sea-level static ISA)**	
Dry:	5480 kp	(12 100 lb)
With reheat:	7170 kp	(15 680 lb)

Basic features
Compressor: 16-stage axial
Combustion system: eight straight-flow interconnected liners
Turbine: two-stage axial
Exhaust system: fully variable afterburner

Weight
Basic dry weight (excluding reheat jet pipes): 1288 kg (2840 lb)

Dimensions
Overall length (excluding reheat jet pipes): 5430 mm (138 in)
Carcase diameter: 1118 mm (44 in)

Spey

Performance	**Mk 202**	**Spey 62 (TF 41-A-1)**
Minimum take-off thrust, sea-level static ISA:	5556 kp (12 250 lb) reheat unlit 9306 kp (20 515 lb) reheat lit	6463 kp (14 250 lb) flat rated to 25°C
Basic features		
Compressor stages:	five low pressure, 12 high-pressure	three low-pressure + two intermediate-pressure, 11 high-pressure
Combustion system:	tubo-annular, ten straight-flow combustion liners	Tubo-annular, ten straight-flow combustion liners
Turbine stages:	Two high-pressure, two low-pressure	Two high-pressure two low-pressure
Weight		
Total dry weight:	1857 kg (4093 lb)	1452 kg (3201 lb)
Dimensions		
Overall length:	5204 mm (204·9 in)	2606 mm (102·6 in)
Intake internal diameter:	826 mm (32·5 in)	952 mm (37·5 in)

Tyne 20

Performance
Take-off power: 6100 tehp, maintained by water methanol injection up to ISA −22·8°C

Basic features
Compressor stages: six low-pressure, nine high-pressure
Combustion system: tubo-annular, ten straight-flow combustion liners
Turbine stages: three low-pressure, one high-pressure
Reduction gear ratio: 0·064:1

Weight
Basic dry weight: 1006 kg (2218 lb)

Dimensions
Overall length: 2743 mm (108·7 in)
Carcase diameter: 1092 mm (43·2 in)

Adour

Performance
Take-off thrust (dry): more than 2000 kp (4400 lb)
Take-off thrust (with reheat): more than 3000 kp (6600 lb)

Basic features
By-pass ratio: 1:1
Compressor stages: two low-pressure, five high-pressure
Combustion system: fully annular
Turbine stages: one high-pressure, one low-pressure

Weight
Basic dry weight: approx 600 kg (1320 lb)

Dimensions
Overall length: 2970 mm (117 in)
Intake diameter: 560 mm (22 in)

RB 162-81

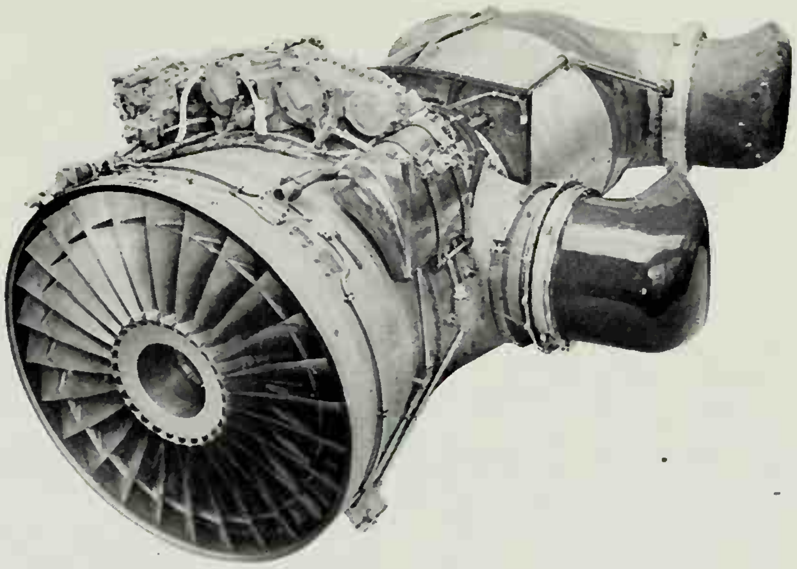
Performance
Take-off thrust (sea-level static ISA):
Normal rating including 8 per cent control bleed: 2718 kp (5992 lb)
Contingency rating including 13 per cent control bleed: 2726 kp (6010 lb)

Basic features
Compressor stages: six
Combustion system: annular chamber with 18 spray nozzles
Turbine stages: one

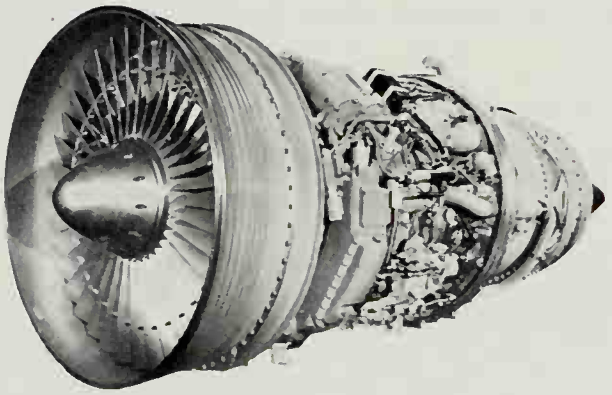
Weight
Nominal weight of basic engine: 188·2 kg (415 lb)

Dimensions
Overall length (fixed nozzle): 1370 mm (54 in)
Maximum diameter: 740 mm (29 in)

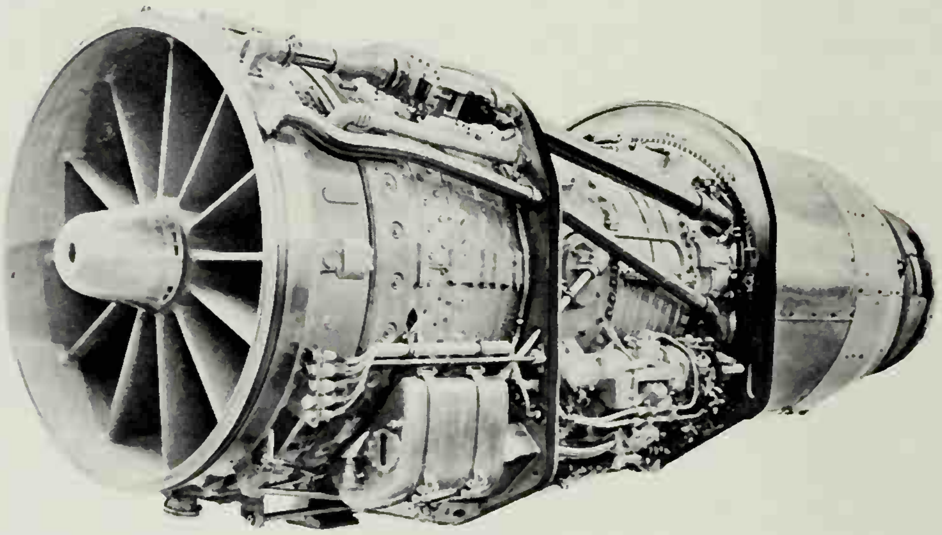
ROLLS-ROYCE LIMITED
Aero Engine Division
PO Box 31, Derby, England
Telephone: Derby 42424 Cables: Roycar Derby Telex: 37645



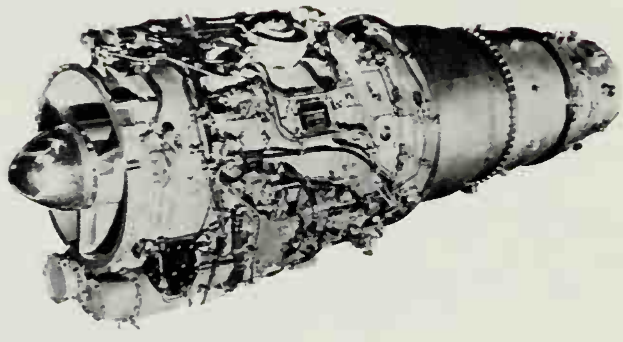
Design of the Pegasus as the world's first vectored-thrust turbofan began in 1956 and the engine was developed for the Hawker Siddeley P 1127 strike aircraft. Now known as the Harrier, this aircraft entered service with the Royal Air Force in 1969 and has been ordered for service with the United States Marine Corps. The Pegasus is also installed in the German Dornier Do 31, the world's first jet-sustained V/STOL transport aircraft. The essential feature of the Pegasus is the use of four directionally controllable thrust nozzles to 'vector' the thrust as required. Present versions are rated at 8618 kp (19 000 lb) thrust but development of a more powerful version of the engine, the Pegasus 11, is now fully funded by the British Government



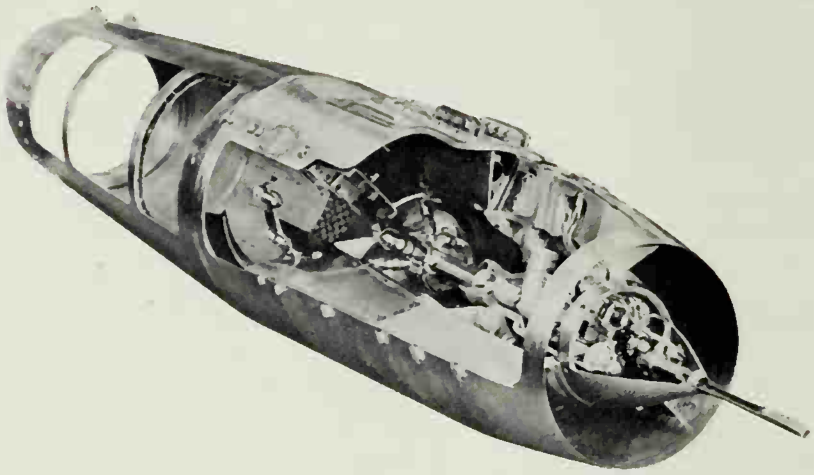
The M 45H is a turbofan of advanced design with modular construction for ease of maintenance and rapid inspection and replacement of components *in situ*. It is being developed jointly by the Bristol Engine Division of Rolls-Royce and the French engine company, SNECMA. The engine first ran in January 1969 (following testing with a 'demonstrator' engine that first ran in June 1966). By the time ARB and FAA approval is granted in 1972 the engine will have logged more than 4000 hours in the air on flight development and more than 4000 hours of bench running. First of the M 45H series powers the VFW 614 short-haul airliner. Development plans show a thrust growth potential up to 4536 kg (10 000 lb)



The Olympus was the first British turbojet engine of the two-spool layout, which gives extreme flexibility and hence excellent handling characteristics. The engine first ran in 1950 and the Mk 101 of 4990 kg (11 000 lb) thrust entered service in the Avro Vulcan in 1956, followed by the Mk 201 in 1960 and the Mk 301 in 1963. More than a million hours have been accumulated in service with the Vulcan. The latest supersonic versions of the Olympus are suitable for operation at speeds up to Mach 2·05 at ISA conditions. Olympus engines equipped with fully variable reheat have completed a considerable amount of running at static thrusts of the order of 17 240 kg (38 000 lb). The Olympus has also been developed for industrial and marine purposes



Since its initial conception in 1948 as a short-life expendable engine for the Jindivik pilotless target drone, the Viper turbojet has been developed into a highly successful engine for military and civil purposes with thrusts up to 1810 kg (4000 lb). The Viper has powered all marks of the BAC Jet Provost trainer and powers the new BAC 167 Strikemaster. The Viper is built under licence by Piaggio of Italy and the Commonwealth Aircraft Corporation of Australia for the Macchi MB 326 trainer. With more than 1½ million hours of service flying now achieved, the Viper is in worldwide operation and powers the basic trainers of 23 foreign air forces



Rolls-Royce's experience in the development and production of ramjets is unique in Europe, work on ramjets having been started in 1949. The ramjet is a versatile propulsion unit suitable for a variety of applications at speeds above Mach 1·5, including surface-to-air defence missiles, target drones and supersonic manned aircraft. The Thor shown at the left is the power unit of the BAC Bloodhound surface-to-air guided missile which is in service with the Royal Air Force and the air forces of Australia, Switzerland, Sweden and Singapore. The Odin is the propulsive unit of the Hawker Siddeley Sea Dart surface-to-air shipborne missile. The Sea Dart is launched by a solid-propellant rocket engine and is thereafter sustained in flight by the Odin

Gas turbine engines

and ramjet engines

The Bristol Engine Division of Rolls-Royce undertakes the design and manufacture of a range of gas turbine engines and ramjets. Among its major products are the Pegasus vectored-thrust turbofan and the M 45 turbofan (in collaboration with SNECMA of France). Well-established turbojets range from the Olympus family (of which the commercial Olympus 593 powers the Concorde supersonic airliner) to the much smaller Vipers. The division will also be responsible for the British share of the work on the RB 199 three-shaft turbofan for the European multi-role combat aircraft (MRCA). For more than twenty years the division has also been developing a series of ramjets.

The Bristol Engine Division, with about 20 000 employees, has its headquarters at Patchway, Bristol in England, and also has factories at Coventry, England.

Specifications

Pegasus

Performance	**Pegasus 6 Mk 101**	**Pegasus 11 Mk 103**
Short-lift rating:	8618 kp (19 000 lb)	9752 kp (21 500 lb)

Basic Features (Pegasus 5)
Fan: three-stage overhung, no inlet guide vanes
Compressor: eight-stage axial
Combustion system: annular
Turbine stages: two high-pressure, two low-pressure (fan)

Weight (Pegasus 5)
Basic engine: 1261 kg (2780 lb)

Dimensions (Pegasus 5)
Flange-to-flange length: 2510 mm (98·84 in)
Diameter (intake flange): 1220 mm (48·05 in)

M 45H-01

Performance
Take-off thrust (sea-level static ISA): 3520 kp (7760 lb)
Specific fuel consumption at this rating: 0·45 kg/h/kp (0·45 lb/h/lb)

Basic features
Compressor: one fan stage coupled to five-stage intermediate-pressure; seven-stage high-pressure
Combustion system: annular
Turbine stages: one high-pressure three intermediate-pressure
By-pass ratio: 2·85:1

Weight
Basic engine: 673 kg (1483 lb)

Dimensions
Overall length: 2600 mm (102·4 in)
Fan casing diameter: 909 mm (35·8 in)

Olympus 301

Performance
Take-off thrust: 9072 kp (20 000 lb)
Specific fuel consumption at this rating: 0·815 kg/h/kp (0·815 lb/h/lb)

Basic features
Compressor stages: six low-pressure, seven high-pressure
Combustion system: annular with eight flame tubes
Turbine stages: one high-pressure, one low-pressure

Weight
Dry: 1946 kg (4290 lb)

Dimensions
Length: 3255 mm (128·0 in)
Maximum diameter: 1130 mm (44·5 in)

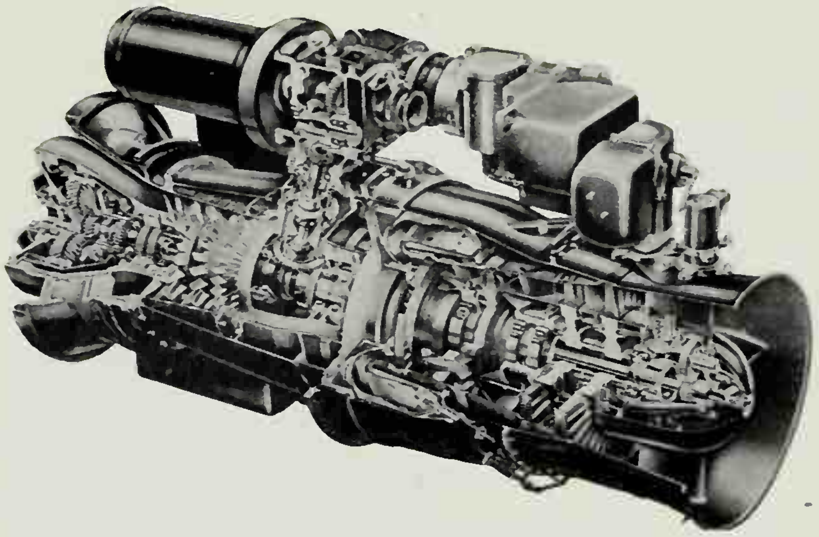
Viper

Performance	**500 Series**	**600 Series**
Take-off thrust	1524 kp (3360 lb)	1814 kp (4000 lb)
Basic features		
Compressor:	eight-stage axial	eight-stage axial
Combustion system:	annular vaporising	annular vaporising
Turbine:	single-stage	two-stage
Weight		
Basic, dry:	345 kg (760 lb)	345 kg (760 lb)
Dimensions		
Length (intake to exhaust flange):	1806 mm (71·1 in)	1806 mm (71·1 in)
Maximum casing diameter:	624 mm (24·55 in)	624 mm (24·55 in)

Thor (early version)

Type: Ramjet comprising a centrebody intake of the two-shock type followed by an annular diffuser leading to the combustion system. The parallel tailpipe terminates in a convergent/divergent final nozzle

ROLLS-ROYCE LIMITED
Bristol Engine Division
PO Box 3, Filton, Bristol, England
Telephone: Bristol 693871 Cables: Brisidair Bristol Telex: 44185



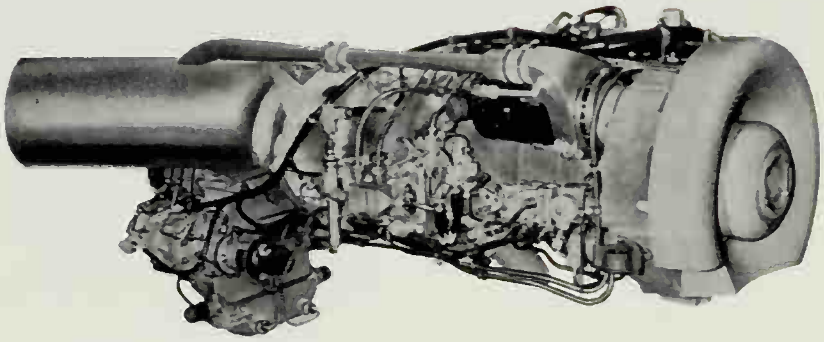
The RS 360, a 900 shp fully modular turboshaft engine, is the result of intensive and detailed studies by Rolls-Royce Small Engine Division into the field of gas turbine engines required to power the next generation of medium helicopters. A variant of this engine, designated BS 360-07, has been selected to power the twin-engined Westland WG 13 multi-purpose helicopter as part of the Anglo-French helicopter programme.

To produce a light, compact and reliable high-performance engine with good handling characteristics that meets military and civil requirements, full advantage has been taken of the extensive gas turbine experience in all divisions of Rolls-Royce Limited.

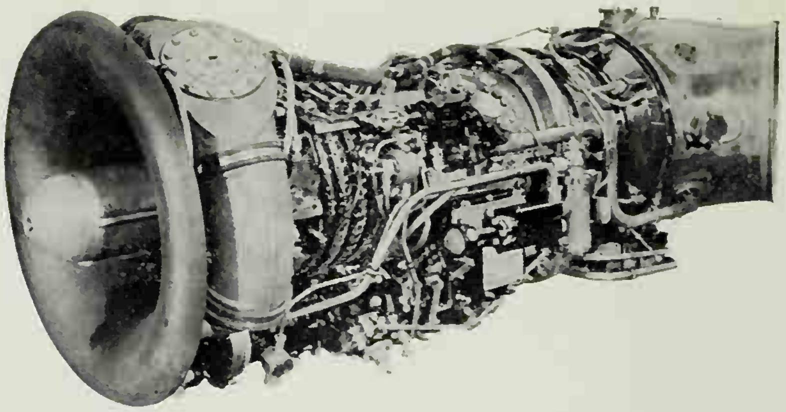
A feature of the engine is the two-spool gas generator which gives a compression ratio of 12½:1 with wide performance characteristics ensuring low specific fuel consumption and good handling qualities without sophisticated compressor variable geometry. This provides the basis for an engine with low overall operating cost.

The incorporation of a modular concept enables major engine components to be replaced without recourse to special equipment or expertise, thus facilitating repair and maintenance in the field and simplifying support logistics by return of modules (instead of complete engines) to contractors for overhaul.

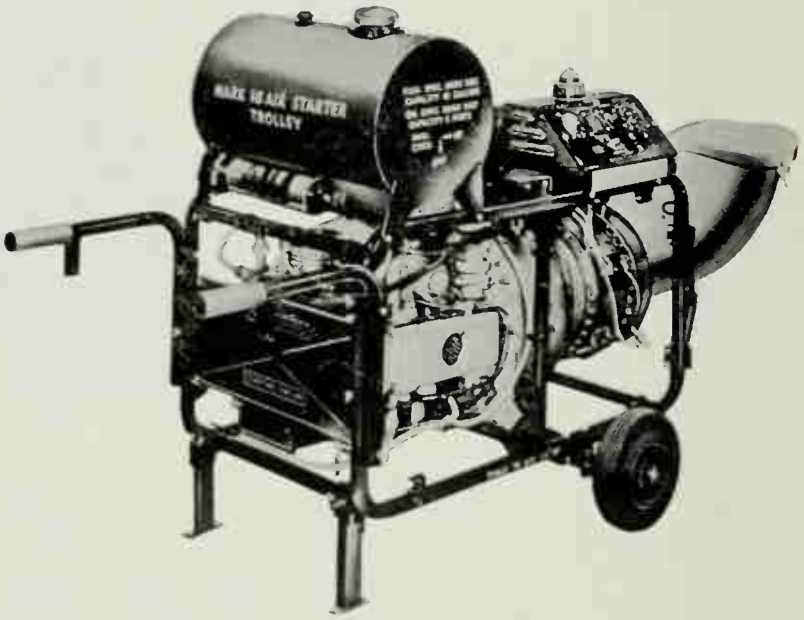
The problem of sea-water corrosion has been largely overcome by the use of anti-corrosive materials in the compressors and the complete absence of magnesium from the engine.



The Nimbus is a small, robust turboshaft engine particularly suitable for helicopters. Nimbus engines currently in production are the Mk 103/503 for the Westland Wasp and the Mk 105/502 for Westland Scout helicopters with a five-minute rating of 710 shp at up to ISA + 25°C at sea level and a five-minute rating of 650 shp at ISA + 30°C up to 2100 m (7000 ft).

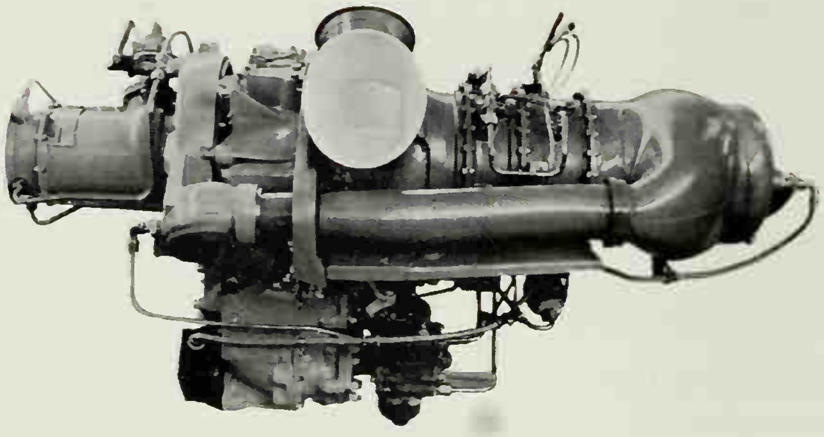


Designed around a high-pressure ratio axial compressor of exceptionally small dimensions, the Gnome is a free-turbine turboshaft engine of 1050–1500 shp. Gnome engines power the Westland Whirlwind Mk 9, Mk 10 and Mk 12, the Westland Wessex Mk 2, Mk 5 and series 60, Westland Sea King, Agusta-Bell Twin 205 and 204B, Augusta 101G (prototype), and the Boeing-Vertol 107 HKP-4. Current engines are the Gnome H 1200 and H 1400.



Developed for the Royal Navy, originally for the Westland Wessex 3 helicopter, the Palouste Mk 18 trolley is a simple, ultra-light, self-contained air starter unit embodying the Rolls-Royce Palouste air-bleed gas turbine. Equipped for aerial transportation by helicopter and suitable for starting many types of aircraft, the Mk 18 trolley incorporates a detachable two-wheel undercarriage equipped with rubber suspension units, and two folding barrow-type handles for ground handling.

The fuel tank capacity is sufficient for up to 15 main engine starts.



By agreement between Allison Division General Motors Corporation and Rolls-Royce Limited, the Small Engine Division is the sole distributor of the Allison Model 250 Series engines for sale and support in the United Kingdom, Europe (excluding Italy), Scandinavia, Finland, Greenland, Iceland, South America, Near East, Middle East, India, Ceylon, Afghanistan and Pakistan. This power unit is used in the Agusta-Bell and Bell Jet Ranger, the Fairchild Hiller FH 1100, the Hughes 500 and the Messerschmitt-Bolkow-Blohm BO 105 helicopter and fixed-wing applications of the turboprop.

Gas turbine engines

Small units for aircraft and general purposes

The Small Engine Division of Rolls-Royce Limited, with about 4200 employees, has the responsibility within Rolls-Royce for the design, development and production of all small gas turbines for use in helicopters and fixed-wing aircraft, as airborne auxiliary power units, air starters and for other applications.

In addition, the Division continues to overhaul and manufacture spare parts for the range of piston engines and gas turbines previously manufactured by the de Havilland and Blackburn engine companies; these comprise the Gipsy, Goblin, Ghost, Gyron Junior, Cirrus, and Bombardier engines.

The Division has its headquarters at Leavesden, Hertfordshire, England, with test facilities and helicopter rotor rigs at Hatfield.

Specifications

RS 360

Description

Contingency rating: 900 shp
Compressor LP spool: four-stage axial
Combustion: reverse-flow annular
Gas generator LP turbine: single-stage axial
Gas generator HP turbine: single-stage axial
Free power turbine: two-stage axial
Modular construction

Weight

Max. basic dry weight: 135 kg (300 lb)

Dimensions

Length: 1092 mm (43 in)
Diameter: 558 mm (22 in)

Nimbus Mk 103 and Mk 105

Performance

	shp	cv	Specific fuel consumption kg/cv/h	lb/shp/h
Five-minute (Mk 103/503)	710	720	0·270	0·595
Five-minute (Mk 105/502)	685	695	0·265	0·582
One hour (Mk 193/503) (Mk 105/502)	685	695	0·265	0·582

Basic features

Free turbine turboshaft helicopter engine
Compressor: two-stage axial and single-stage centrifugal
Combustion: Single annular chamber
Gas generator turbine: two-stage axial
Free power turbine: single-stage axial

Weight

Installed engine:
Mk 103/503 304 kg (670 lb)
Mk 105/502 297 kg (655 lb)

Dimensions

Length (air intake to exhaust duct): 1872 mm (73·7 in)
Width (across exhaust ducts): 933 mm (38·7 in)
Height (gearbox sump to oil tank filler): 853 mm (33·6 in)

Gnome H1400

Performance

	shp	cv	Specific fuel consumption kg/cv/h	lb/shp/h
Contingency	1500	1521	0·272	0·607
Max. one hour	1400	1420	0·273	0·610

Basic features

Free turbine turboshaft helicopter engine
Compressor: ten-stage axial
Combustion: single annular chamber
Gas generator turbine: two-stage axial
Free power turbine: single-stage axial; 19 500 nominal rev/min

Weight

Max. basic dry weight: 153 kg (337 lb)

Dimensions

Length: 1392 mm (54·8 in)
Diameter: 574 mm (22·6 in)

Palouste Mk 18 Trolley

Performance

Max. air delivery 15A sea level: 0·9 kg/sec (2 lb/sec)
Air delivery pressure ratio: 3·62:1
Air delivery temperature: 220°C (428°F)

Weight

Dry weight, fully equipped: 263 kg (579 lb)
Weight, air-transportable pack: 216 kg (475 lb)

Dimensions

Length: 1930 mm (6 ft 4 in)
Width: 914 mm (3 ft)
Height: 1118 mm (3 ft 8 in)

Allison Model 250 Turboprop

Performance

		shp	cv	Total equiv. power te hp	te cv	Prop speed rev/min	Spec. fuel consumption kg/te cv/h	lb/te hp/h
B15	Take-off	317	321	330	334	2025	0·300	0·670
	Max. cont.	270	274	281	285	2025	0·303	0·678
B17	Take-off	400	405	418	324	2025	0·270	0·603
	Max. cont.	346	351	362	367		0·276	0·616

Basic features

Lightweight turboprop engine
Compressor: six-stage axial, one stage centrifugal
Combusion: single chamber
Gas-producer turbine: two-stage axial
Free power turbine: two-stage axial
Controls: optional, two-lever incorporating fall Beta control

Weight

B15—77·6 kg (171 lb)
B17—86·2 kg (190 lb)

Dimensions

B15—Length: 1134 mm (44·6 in)
Height: 572 mm (22·5 in)
Width: 483 mm (19 in)
B17—Length: 1138 mm (44·8 in)
Height: 572 mm (22·5 in)
Width: 483 mm (19 in)

Allison Model 250 Turboshaft

Performance

		shp	cv	Output speed rev/min	Spec. fuel consumption kg/cv/h	lb/shp/h
C18	Take-off	317	321	6000	0·312	0·697
	Max. cont.	270	274	6000	0·316	0·706
C20	Take-off	400	405	6000	0·282	0·630
	Max. cont.	346	351	6000	0·288	0·645

Basic features

Lightweight turboshaft engine
Compressor: six-stage axial, single stage centrifugal
Combustion: single chamber
Gas producer turbine: two-stage
Free turbine: two-stage axial

Weight

C18—64 kg (141 lb)
C20—70·3 kg (155 lb)

Dimensions

C18—Length: 1024 mm (40·3 in)
Height: 589 mm (23·7 in)
Width: 483 mm (19 in)
C20—Length: 1034 mm (40·7 in)
Height: 589 mm (23·7 in)
Width: 483 mm (19 in)

ROLLS-ROYCE LIMITED
Small Engine Division
Leavesden, Watford, WD2 7BZ, England
Telephone: Garston 74000 Cables: Rollsed Watford Telex: 23206

ROLLS RR ROYCE

Section 17

Helicopters and hovercraft

Sea King (right)

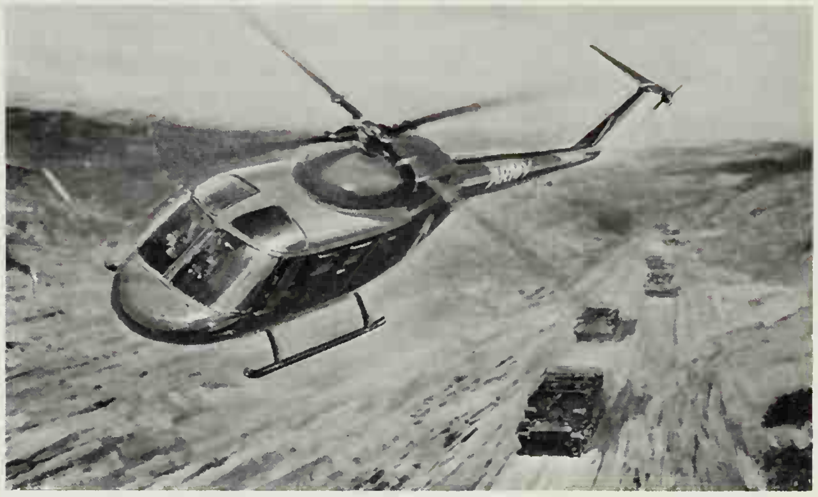
The Sea King, the world's most advanced anti-submarine search and strike helicopter, is now in operational squadron service with the Royal Navy. This versatile and powerful long-range helicopter is fitted with two Rolls-Royce Gnome H 1400 gas turbine engines of 1500 shp each. Its equipment includes the latest automatic flight control system and an integrated sonar-radar tactical display.

Although the primary role of Sea King is all-weather anti-submarine operations from either ship or shore, it can be readily adapted to a number of secondary roles, including commando transport, air/sea rescue and mine sweeping.

SA 341 (right)

The SA 341 is one of three helicopter types involved in the Anglo/French helicopter co-operation agreement. Several hundreds of this helicopter are required for the British Army and the French Army and the production of these is being shared by both Westland Helicopters Limited and Société Nationale Industrielle Aerospatiale.

An advanced general-purpose light helicopter, this five-seat machine is powered by a Turbomeca Astazou 3N turbine engine. The streamlined body gives it an extremely high operating speed, and ease of maintenance is one of the main design features.



Wessex 50 (right)

The Wessex 50 is the military counterpart of the civil Wessex 60 currently operating on oil rig support duties in many parts of the world. Powered by coupled 1350shp Rolls-Royce Gnome free turbines, the Wessex 50 is currently operating with the Royal Air Force as the Wessex Mk 2, and with the Royal Navy as the Mk 5.

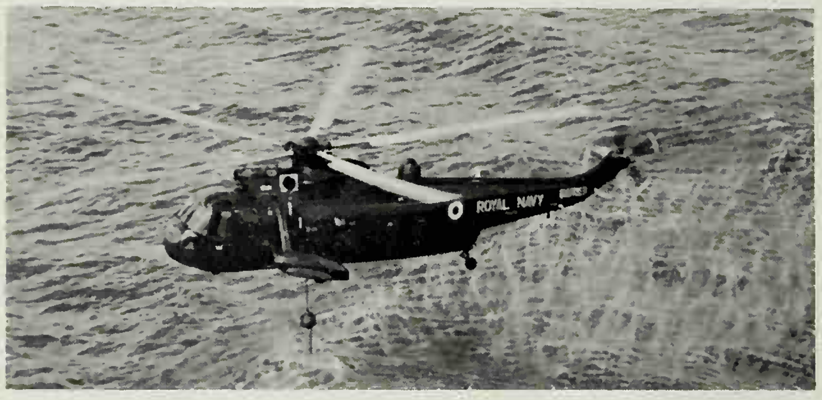
Operation with these two Services has taken this extremely versatile helicopter into many countries throughout the world, and the machine's ability to cope with the vastly differing terrains and climatic conditions has proved that the Wessex offers operational capabilities second to none.

Wasp (left)

Currently in service with the Royal Navy, as well as with four other leading navies of the world, the British-designed and built Wasp has proved to be a very capable helicopter for shipborne operation.

Powered by a Mk 503 Rolls-Royce Nimbus gas turbine, this 5/6 seat general-purpose helicopter has a specially designed undercarriage, incorporating fully castoring lockable wheels allowing normal operation from small platforms on destroyers and frigates in adverse weather and sea conditions. Anti-coning and anti-droop stops in the main rotor head facilitate starting and stopping in high winds.

The Wasp also has facilities for the addition of a power hoist for rescue missions, and the rear seats and stretcher installations can be folded back to provide adequate freight stowage space.



SA 330 (left)

Currently being built by Westland Helicopters Limited and Société Nationale Industrielle Aerospatiale, the SA 330 will be the new tactical helicopter for operation by the French Armed Forces and the Royal Air Force.

The SA 330 is a twin-turbine aircraft with a four-bladed main rotor and a five-bladed tail rotor. It has all-terrain landing gear and easy accessibility for maintenance, facilitating a quick change of major components. It is capable of a number of operational roles, including troop transport (carrying 16 fully equipped troops), ambulance duties, search and rescue and freight transport. There is also a VIP transport version.

WG 13 (left)

Artist's impression of the general-purpose version of the WG 13 for the British Army. This versatile helicopter will be able to accommodate 9 passengers plus a crew of two, or, alternatively, three standard stretchers with a medical attendant and one seated patient. Externally mounted armament can be carried, and a power hoist also installed for air/sea or mountain rescue operations.

The British designed and developed WG 13 forms part of the Anglo/French co-operation agreement, which also covers the shared production of the SA 330 and SA 341 designed and developed by Sud Aviation of France. It is scheduled to enter service in the early 1970s.

Helicopters

for military and civil duties

The current range of helicopters available from Westland Helicopters Ltd—together with those now in development, and including the machines involved in the Anglo/French helicopter agreement—will fill most civil and military requirements in the Western world throughout the 1970s and into the 1980s. Particulars and general specifications of these aircraft are given here.

Wasp

Weight summary
Manufacturer's basic weight 1672kg (3687lb)
Pilot 82kg (180lb)
Disposable load 741kg (1633lb)
Maximum all-up weight 2495kg (5500lb)
Maximum fuel 563kg (1240lb)

Performance at 2500kg (5500lb) AUW in ISA conditions
Maximum speed 194km/h (105 knots)
Maximum cruising speed 178km/h (96 knots)
Maximum range, standard fuel tankage 487km (263nm)
Maximum rate of climb 7.3m/sec (1440ft/min)
Hovering ceiling out-of-ground effect 2682m (8800ft)
Hovering ceiling in ground effect 3810m (12 500ft)

Dimensions
Main rotor dia 9·83m (32ft 3in)
Overall length 12·3m (40ft 4in)
Tail rotor dia 2·29m (7ft 6in)
Overall height 3·56m (11ft 8in)
Wheel track 2·64m (8ft)

Sea King

Weight summary
Manufacturer's basic weight 5520kg (12 170lb)
Pilot plus two crew 272kg (600lb)
Disposable load 3506kg (7730lb)
Maximum all-up weight 9299kg (20 500lb)
Maximum fuel 2495kg (5500lb)

Performance at 9300kg (20 500lb) in ISA conditions
Maximum speed 235km/h (123knots)
Maximum cruising speed 211km/h (131 knots)
Maximum range (standard fuel) 1120km (600nm)
Carries 3200kg (7000lb) payload for 92km (50nm) radius
Maximum rate of climb 15·2m/sec (3000ft/min)

Dimensions
Main rotor dia 18·89m (62ft)
Overall length 22·15m (72ft 8in)
Tail rotor dia 3·16m (10ft 4in)
Overall height 5·13m (16ft 10in)
Wheel track 3·96m (13ft)
Overall width (with flotation gear) 4·99m (16ft 4in)

SA 330

Overall dimensions (rotor turning)
Length 18·18m (59·6ft)
Width 15·00m (49·2ft)
Height 5·12m (16·8ft)

Overall dimensions (blades folded)
Length 14·80m (48·5ft)
Width 3·50m (11·5ft)
Height 5·12m (16·8ft)

Weights
Empty weight (without operational equipment) 3290kg (7253lb)
Total weight 6400kg (14 110lb)

Power plant
Two free-turbine engines Turmo III C.4
Constructor Turbomeca
Power rating (each) 1300hp

SA 341

Weight summary
Maximum gross weight 1600kg (3530lb)
Overload maximum gross weight 1700kg (3750lb)
Empty weight 800kg (1765lb)

Performance at 1600kg (3530lb) AUW in ISA conditions
Maximum range 690km (370nm)
Maximum speed in excess of 140 knots

Dimensions
Main rotor dia 10·5m (34ft 5⅜in)
Overall length (with rotor turning) 12·10m (39ft 8⅜in)
Ducted tail rotor dia 0·69m (2ft 3in)
Overall height 2·96m (9ft 8½in)
Skid track 1·93m (6ft 4in)
Its typical uses include passenger transport, casualty evacuation, freight transport and reconnaissance duties

WG 13

Weight summary
Empty weight 2347kg (5175lb)
Equipment, radios and miscellaneous 40kg (88lb)
Oil 16kg (36lb)
Pilot 82kg (180lb)
Full fuel 726kg (1600lb)
Payload 418kg (921lb)
Take-off weight 3629kg (8000lb)

Performance at the normal all-up weight of 3630kg (8000lb) and at ISA ±20°C
Speed at sea level maximum sustained 160 knots
Free air hover 3050m (10 000ft)
Forward climb at sea level 810m/min (2650ft/min)
(maximum continuous rating)
Level flight—fuel consumption, sea level 0·845kg/km (3·45lb/nm)
Single engine forward climb,
Sea level (inter-contingency rating) 225m/min (740ft/min)
Maximum range, standard fuel (no reserves) 870km (470nm)
Auxiliary fuel—take-off at 3860kg (8500lb) —with reserves 1850km (1000nm)

Dimensions
Main rotor dia 12·8m (42ft)
Tail rotor dia 2·2m (7ft 3in)
Overall length (rotor turning 15·2m (49ft 9in)
Overall width (rotor turning) 12·8m (42ft)
Maximum height (tail rotor turning) 3·7m (12ft)
Overall length (blades folded) 12·8m (41ft 10¾in)
Skid undercarriage track 2m (6ft 8in)

Power plant
Two Rolls-Royce BS.360-07 free-turbine engines

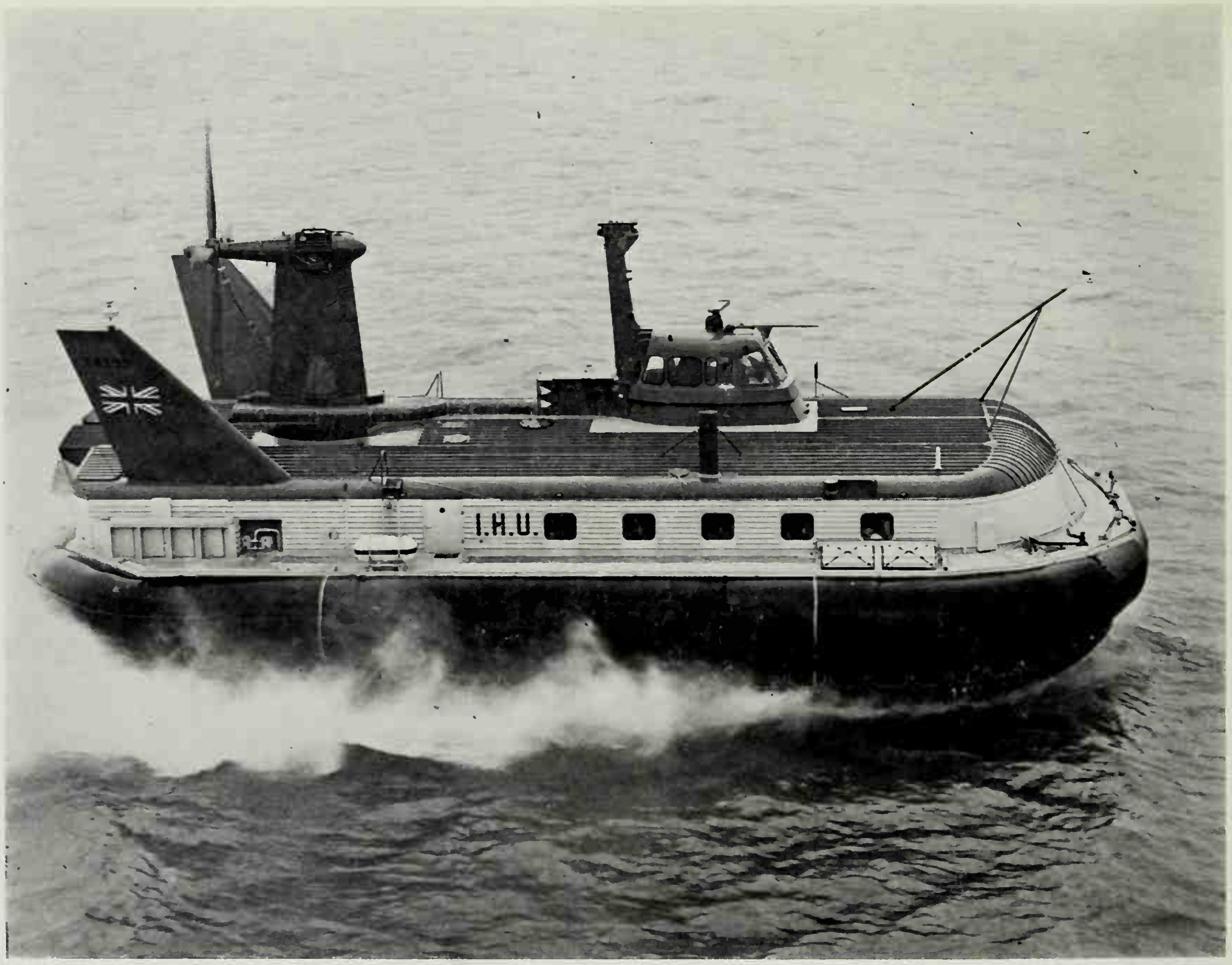
Wessex 50

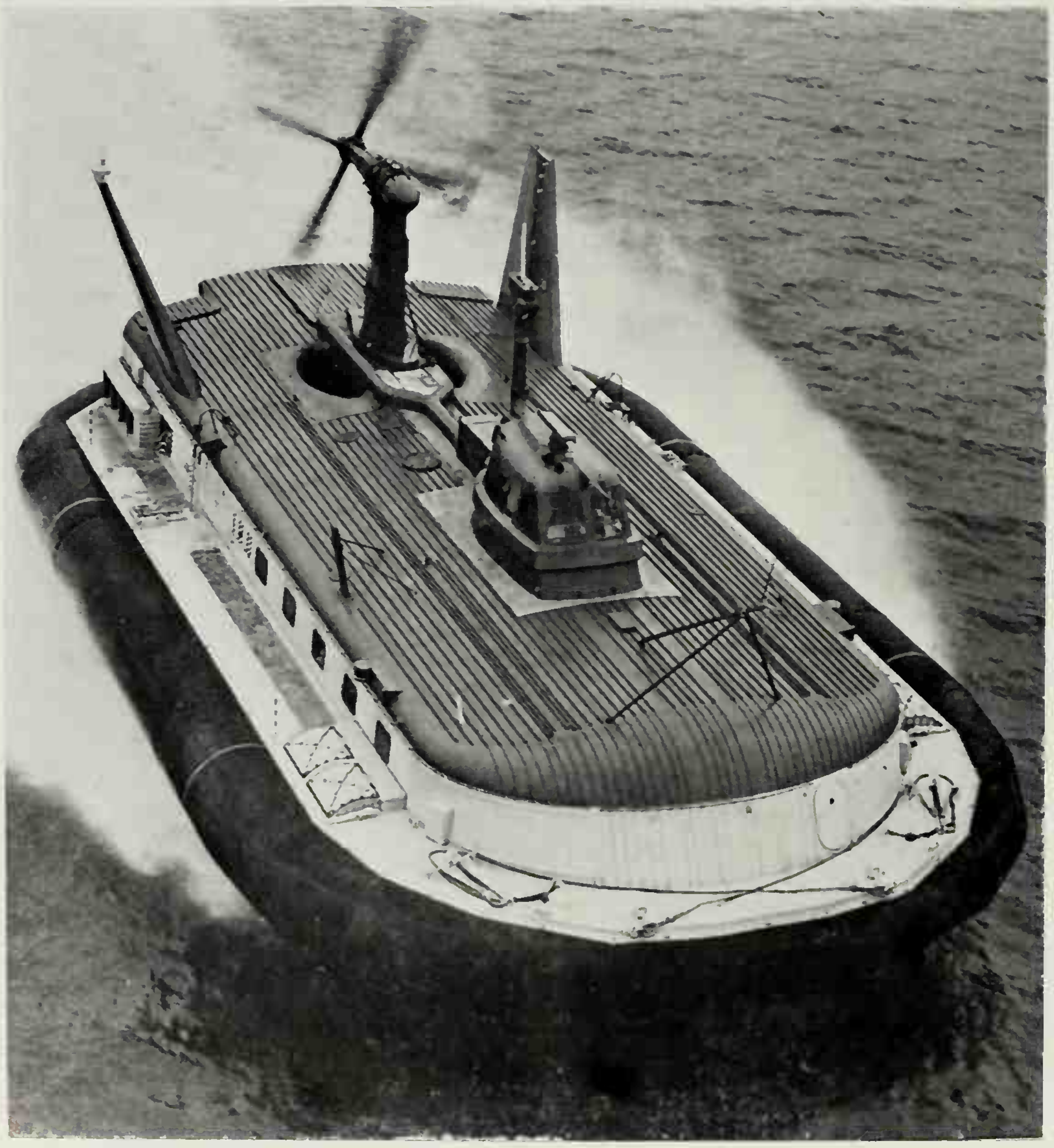
Weight summary
Manufacturer's basic weight with standard equipment 3674kg (8100lb)
Oil 33·5kg (74lb)
Crew 77kg (170lb)
Disposable load 2389kg (5256lb)
All-up weight 6169kg (13 600lb)
Maximum fuel 1125kg (2480lb)

Performance at 6170kg (13 600lb) AUW in ISA conditions
Maximum speed 215km/h (116 knots)
Maximum cruising speed 193km/h (104 knots)
Maximum range 537km (290nm)
Best rate of climb at sea level 7·8m/sec (1540ft/min)
Vertical rate of climb at sea level 3·1m/sec (620ft/min)

Dimensions
Main rotor dia 17·07m (56ft)
Overall length 20·03m (65ft 10½in)
Nose-to-tail rotor distance 15·18m (49ft 11in)
Overall height at main rotor 4·9m (16ft 2in)
Wheel track 3·66m (12ft)

WESTLAND HELICOPTERS LIMITED — *a subsidiary of Westland Aircraft Limited*
Yeovil, Somerset, England
Telephone: Yeovil 5222 Cables: Aircraft Telex Yeovil Telex: 46277





The general arrangement of the craft is for front-loading with the engine sited aft and the propeller mounted on a swivelling pylon. The control cabin is on top of the main cabin. The bow is fitted with a 'clamshell' door. The buoyancy tank, two main longitudinal walls either side of the central main cabin, superstructure and machinery and systems aft of the control cabin are common to the various versions of the craft. The forward superstructure is designed so that it can be adapted to the required variant with the minimum change.

The fan intake, control cabin and other double-curvature surfaces are of glass-reinforced plastics.

Although new in design, the Wellington makes extensive use of components and constructional techniques employed on the Mountbatten. The engine, transmission gearboxes and propeller are identical with those of the larger craft. Directional control is achieved by the swivelling propeller pylon; the air-porting and skirt-lift system are similar to that used on the Winchester and the Warden.

Two small auxiliary power units provide electrical supplies independent of the main engine. Radar and other navigational aids enable the craft to operate effectively in bad weather and at night.

Wellington

BH.7 logistics and fast attack hovercraft

The Wellington (BH.7) Class is the first hovercraft to be designed from the outset as a naval vessel, combining a good payload or weapons system with real sea-keeping ability and high performance. There are two basic types of the Wellington, the logistics craft and the fast attack craft.

Logistics craft
This type of craft has a large unobstructed centre cabin with access via a large 'clamshell' bow door. The centre cabin is designed to carry vehicles; troops and small stores are carried in side cabins.

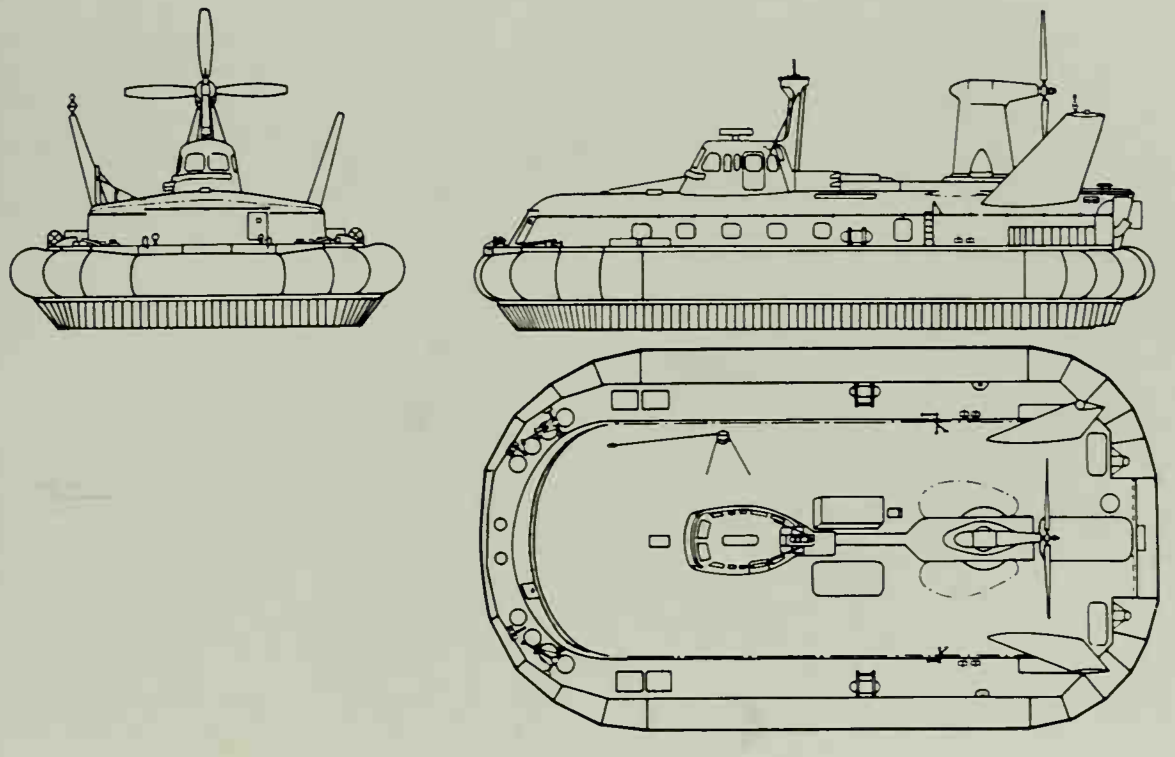
For logistic work, ancillary equipment and armament are kept to a minimum to give a greater payload capacity. However, lightweight armour can be fitted at the expense of payload, to protect vital areas such as the control cabin and engine.

Typical loads are three ¾-ton trucks with 60 equipped troops, or six ¾-ton trucks, or two Scout cars, or 170 fully equipped troops.

Fast attack craft
This craft features a modified bow to give optimum sea-keeping qualities. Various internal layouts can be adopted depending on service requirements and weapon fits and there is ample deck area for an operations room, crew quarters, galley, etc. Air conditioning can be fitted for use in tropical areas.

Armament fits are designed to suit the specific requirements of individual customers and current studies include 20 mm automatic turrets, surface-to-surface and surface-to-air short-range guided missiles with optical or television sighting and intermediate range surface-to-surface guided missiles with full fire-control radar giving a 'dark fire' and 'over the horizon' capability.

Armour plating, radio and radar fits and fuel capacity are all compatible with the armament and envisaged role.



Specification

Dimensions
Overall length: 23·52 m (77 ft 2 in)
Overall beam: 13·86 m (45 ft 6 in)
Overall height on landing pads: 10·1 m (33 ft)
Hover height: 1·6 m (5 ft 6 in)

Weights
Normal gross weight: 45 tons
Fuel load at 45 tons all-up weight: 9 tons
Max fuel capacity: 12·5 tons

Power plant and systems
Main engine: Rolls-Royce Marine Proteus at 3400 shp max continuous power
Auxiliary power plant: two Rover 1S/90 gas turbines
Fan: BHC 12-bladed, centrifugal, 3·5 m (11 ft 6 in) dia
Propeller: HSD 4-bladed, controllable pitch, 5·8 m (19 ft) dia

Performance
at normal gross weight, at 15°C
Max water speed: 65 knots (120 km/h) in calm water, no wind
Rough water speed: 35–45 knots (65–85 km/h) in 1·34 m (4½ ft) seas, depending on heading and wave length
Endurance: 8 hours at max continuous rating on 8 tons of fuel with 10% reserve

BRITISH HOVERCRAFT CORPORATION
East Cowes, Isle of Wight, England
Telephone: Cowes 4121 Cables: Brithover Cowes Telex: 86190

A Winchester (SR.N6) Class craft of 200 Squadron, Royal Corps of Transport attacks a beach during amphibious assault exercises

One of eight Winchesters now in squadron service with the Imperial Iranian Navy

A Winchester Class craft which is in service with the Royal Navy in the Falkland Islands as a troop transport and communications craft

Winchester

SR.N6 Class military hovercraft

Since its introduction to commercial and military service in 1965, the Winchester (SR.N6) Class hovercraft has logged more hours than all other types of hovercraft put together in operations in all parts of the world.

This experience has played a significant part in the successful development of the Winchester as a fast, dependable and versatile vehicle ideally suited for naval and other military duties.

To date, these craft have entered fully operational service with the defence forces of four nations. Being fully amphibious, the Winchester can cross surf, beaches, marshes, swamps, scrubland, snow and ice without hindrance and is capable of establishing reliable lines of communications in areas denied to other forms of transport.

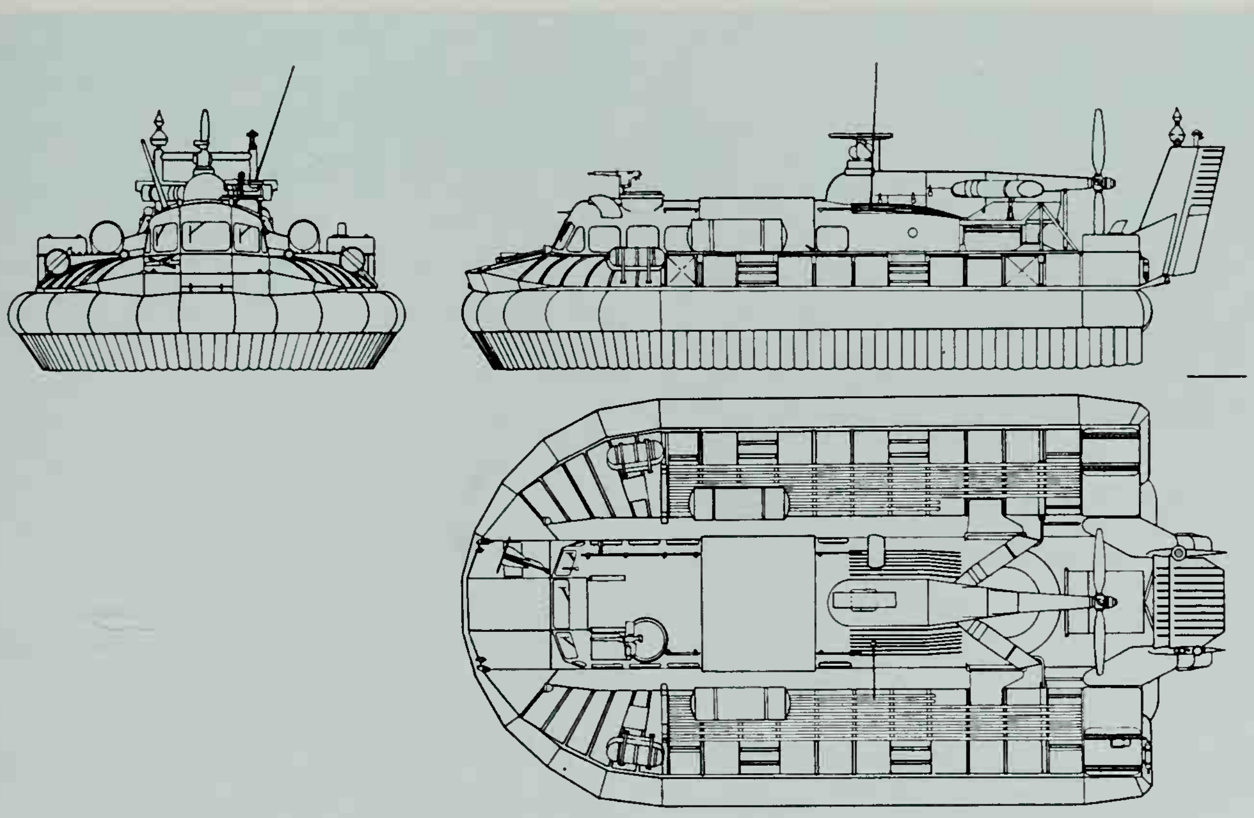
At an all-up weight of 11 000 kg, the Winchester can be fitted with a wide variety of equipment for military duties. This equipment can include light defensive armament and armour, strengthened side decks to facilitate loading/unloading from ships, racks for carrying external loads, a roof hatch for crane loading, air conditioning or forced-draught ventilation and heating equipment and a wide array of sophisticated radio and navigation equipment.

All installations have been carefully engineered to ensure maximum efficiency and reliability at sea level.

Operational advantages

The military effectiveness of the Winchester lies in its unique combination of abilities:

High speed
Amphibious capability
Minimal crew requirements
Proven reliability
Role versatility
Design simplicity
Rugged structure
Invulnerability
Ease of deployment
Endurance



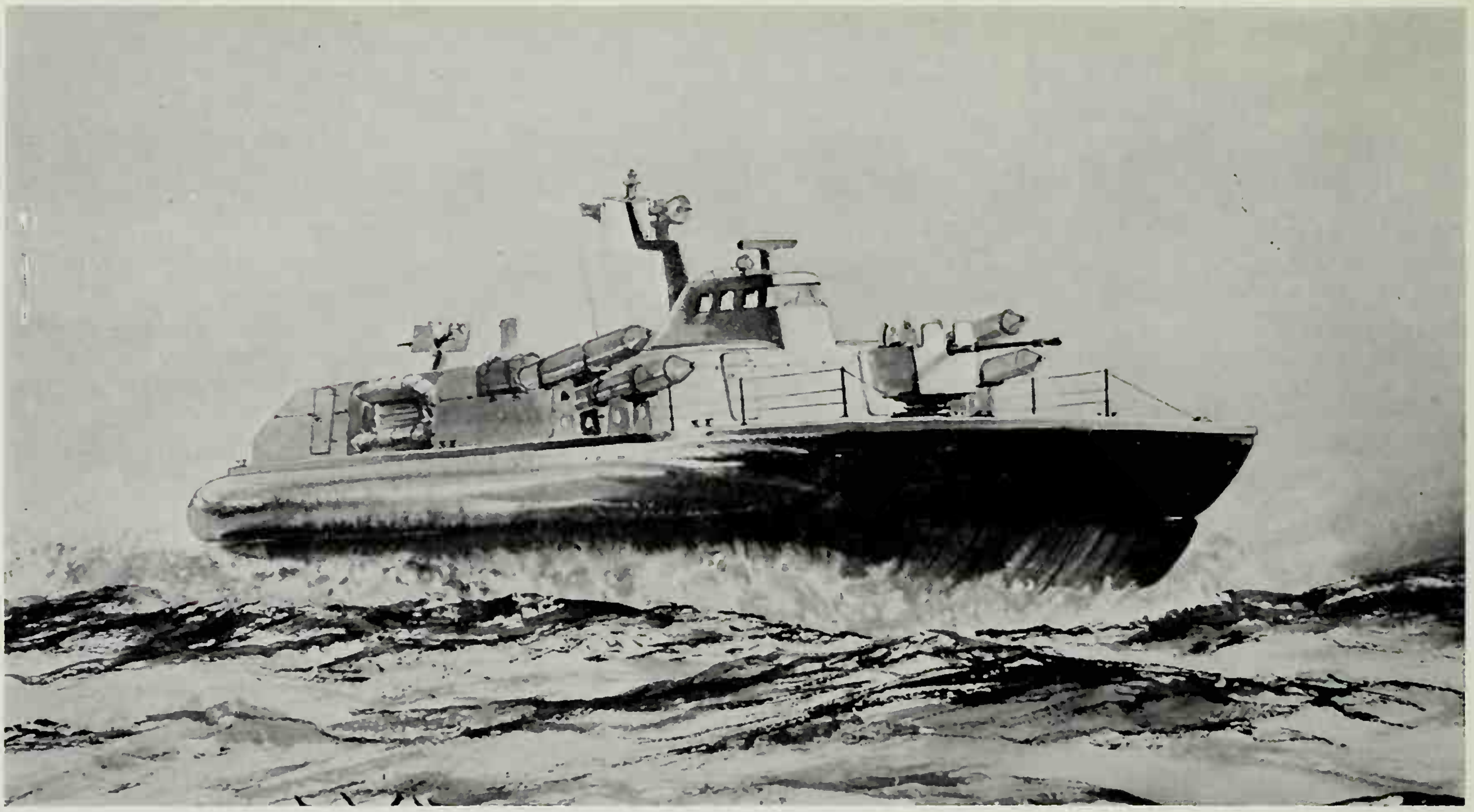
Specification

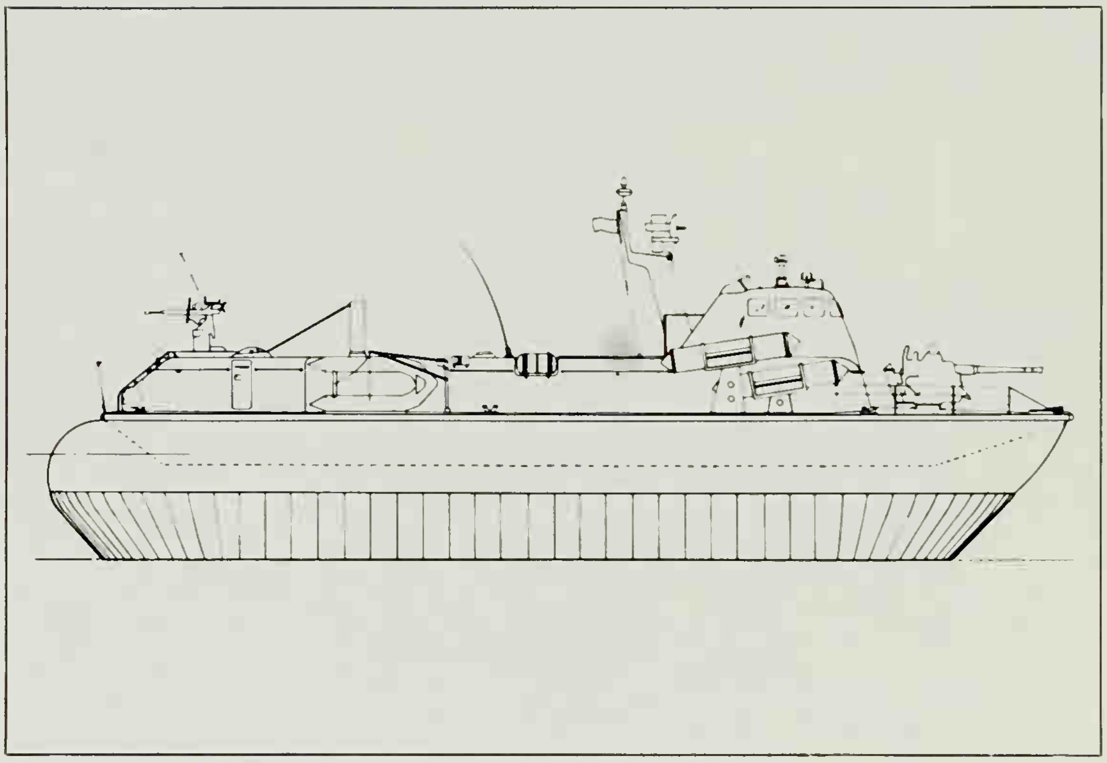
Dimensions
Overall length: 14·76 m (48 ft 5 in)
Overall beam: 7·01 m (23 ft)
Overall height on landing pads: 4·57 m (15 ft)
Cabin size (length × width): 6·62 × 2·34 m (21 ft 9 in × 7 ft 8 in)
Cabin headroom at centre line: 1·83 m (6 ft)
Door aperture (height × width): 1·75 × 0·99 m (5 ft 9 in × 3 ft 3 in)
Skirt length: 1·22 m (4 ft)
Normal gross weight: 10·7 tons

Power plant and systems
Engine: Rolls-Royce Gnome gas turbine
Max continuous rating: 990 shp at 15°C
Propeller: Dowty Rotol 4-bladed, variable pitch 2·74 m (9 ft) dia
Lift fan: BHC 12-bladed, centrifugal 2·13 m (7 ft) dia
Normal fuel capacity: 1200 litres (265 gal)
Additional fuel capacity: 900 litres (200 gal)

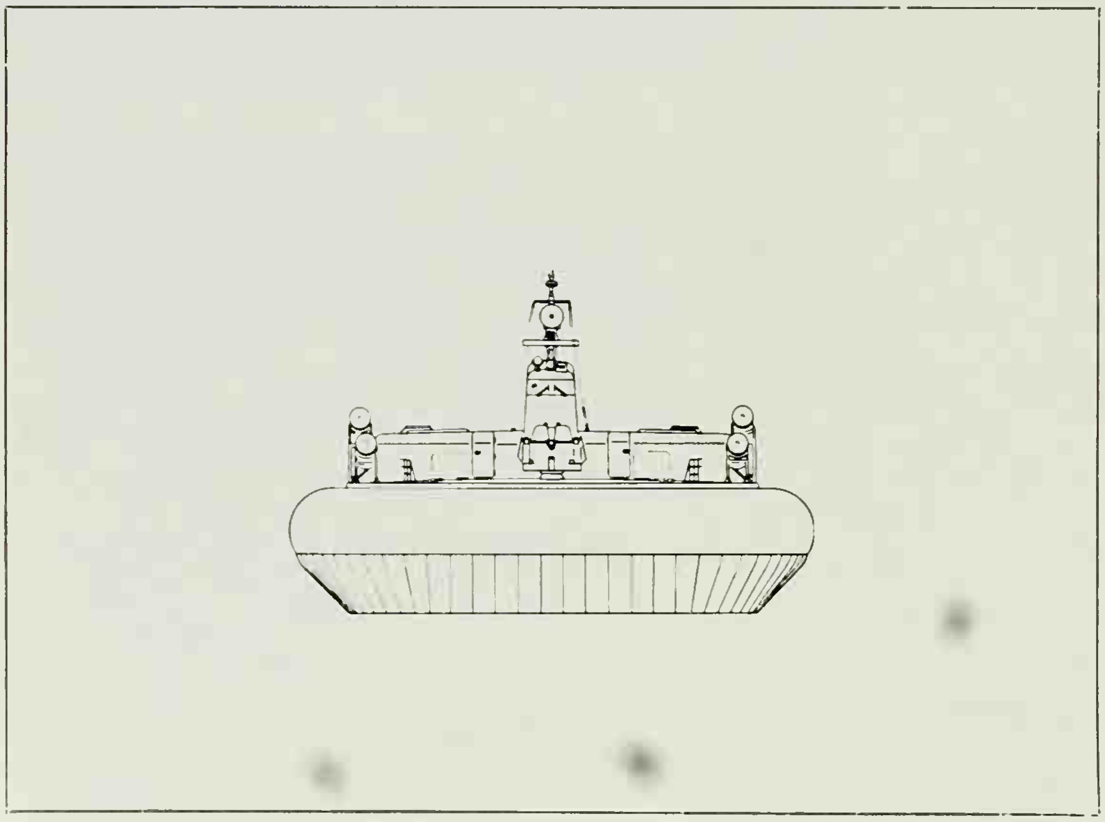
Performance
at normal gross weight at 15°C
Max water speed: 50 knots (92 km/h) on calm water, no wind, continuous power rating
Average service water speed: 30–35 knots (55–65 km/h) in sheltered coastal waters
Endurance: 3·6 hours at max continuous power rating on 1200 litres (265 gal) fuel
Long-range endurance: 5·7 hours with additional fuel

BRITISH HOVERCRAFT CORPORATION
East Cowes, Isle of Wight, England
Telephone: Cowes 4121 Cables: Brithover Cowes Telex: 86190





An artist's impression of the VT1. The armament is variable, but this version shows a 40 mm gun forward and a 20 mm gun aft. It also shows as main armament four Sea-killer missiles, each with a range of 20 km and the hitting power of a six-inch shell. Control is by means of the Sea-hunter control system complete with its own radar. A separate navigation radar is also fitted



Specification
Length overall: 30 m (98·5 ft)
Breadth overall: 16·3 m (53·5 ft)
All-up weight: 100 tons
Fuel and armament weight: 40 tons—60 tons
Maximum speed: over 110 km/h (60 knots)
Range: 750–1500 km (400–800 nm) according to amount of fuel carried

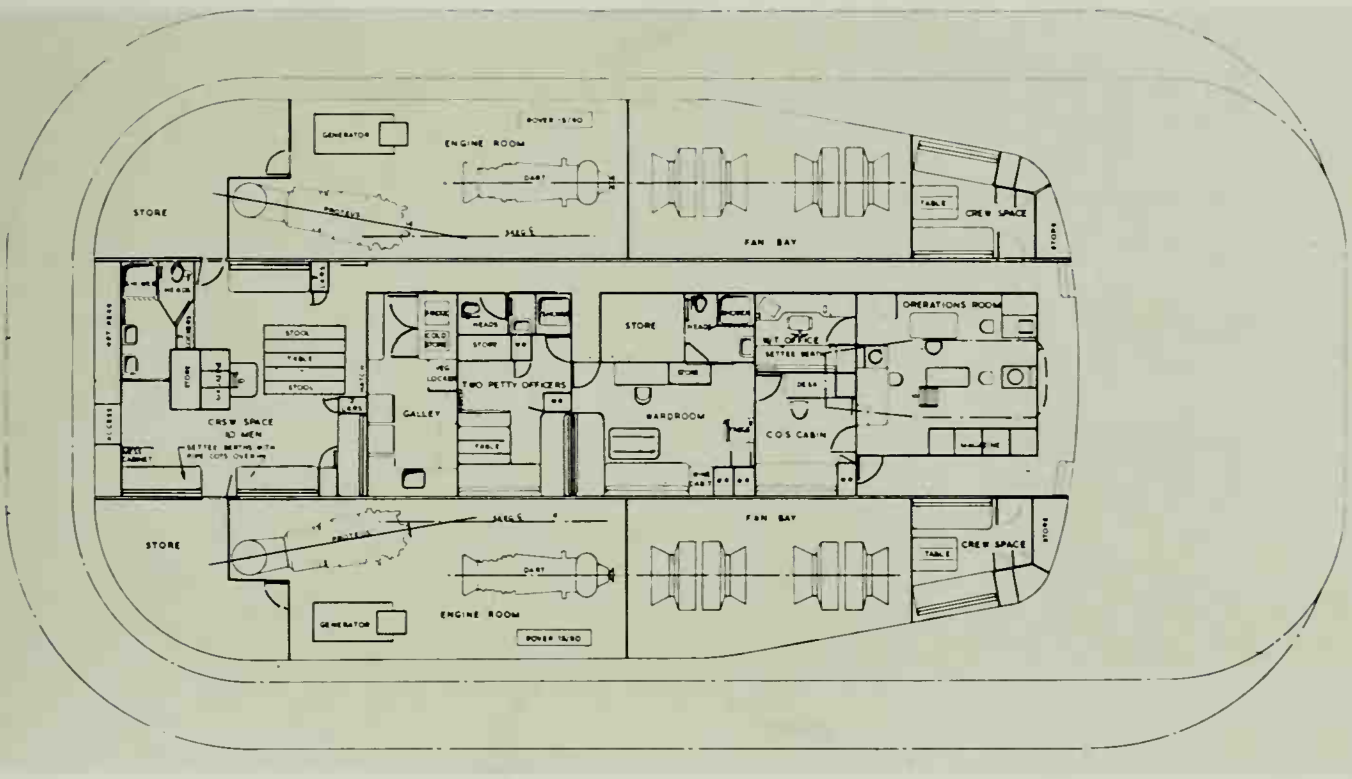
Hovercraft

Military version of Vosper Thornycroft VT1

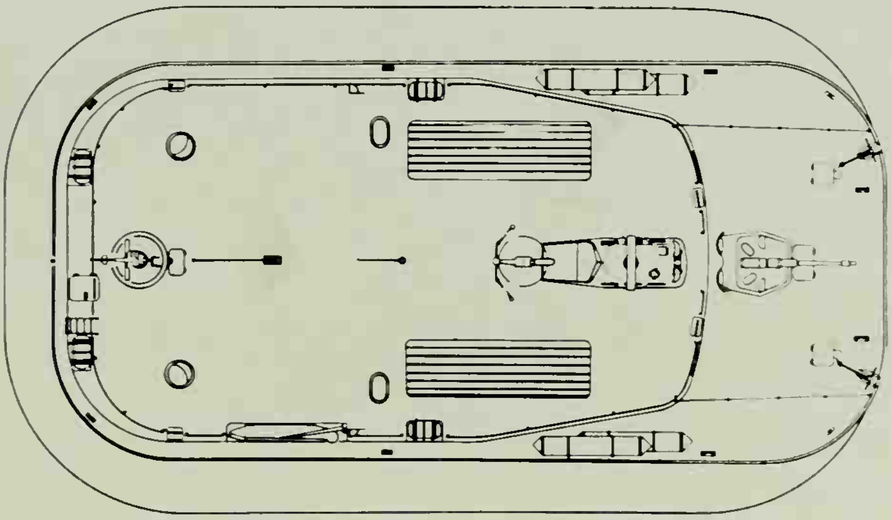
The 80-ton semi-amphibious Vosper Thornycroft VT1 hovercraft design can be adapted to a military role. A higher performance will result from the installation of two Rolls-Royce Proteus gas turbines as the main propulsion machinery and two Rolls-Royce Darts as the lift machinery, with a greater depth of skirt for improved sea-keeping ability. Propulsion can be by means of water jets contained in retractable skegs. The craft will have a speed of over 110km/h (60 knots). It will be able to operate in nominal water depths with some ability to clear obstacles such as logs, sandbars and submerged booms.

Underwater propulsion prevents the operation of the craft overland, but there are compensating advantages. The immersed skegs enable the craft to be accurately manoeuvred in cross winds and the absence of air propellers not only reduces the noise but also leaves the upper deck clear so that there is a good all-round view from the control cabin and wide arcs of fire for the weapons.

A fairly considerable and widely varying armament load can be carried. That shown in the illustrations is a possible arrangement but other configurations are available to meet particular requirements.


STORE
GENERATOR
ENGINE ROOM
DART
PROTEUS
SKEG
FAN BAY
TABLE
CREW SPACE
STORE
STOOL
TABLE
STOOL
STORE
CREW SPACE
10 MEN
SETTEE BERTHS WITH PIPE COTS OVER
GALLEY
COLD STORE
HEADS
TWO PETTY OFFICERS
TABLE
STORE
HEADS
WARDROOM
OPERATIONS ROOM
C.O.S CABIN
FAN BAY
CREW SPACE
TABLE
STORE
STORE
GENERATOR
ENGINE ROOM
DART
PROTEUS
SKEG

The accommodation can provide for a crew of some 20 officers and men and is generally similar to that of a modern fast patrol boat, with ample space in the operations room and a separate cabin for the commanding officer.



VOSPER THORNYCROFT
Shipbuilding Division
Vosper House, Paulsgrove, Portsmouth, England
Telephone: Cosham 79481 Telex: 86115

1966
1969

Hovercraft skirts and skirt systems

Avon designs, develops and manufactures skirts and skirt systems under licence from Hovercraft Development Limited.

Experience with coated fabrics, sophisticated manufacturing equipment, supported by extensive rubber and textile laboratories, ensure the technical ability to provide an advisory service on hovercraft skirt systems and hovercraft materials for particular applications.

A hovercraft projects group within the Avon Group of companies provides a technical advisory service on materials and skirt systems and maintains close liaison with all the major hovercraft manufacturers throughout the world.

Avon Rubber Co Ltd
Bradford-on-Avon, Wiltshire, England

Telephone: Bradford-on-Avon 2191
Cables: Industrial Bradford-on-Avon
Telex: 44856

Section 18

Weapons and control systems for aircraft

Hunter T7

Sea Vixen

Buccaneer

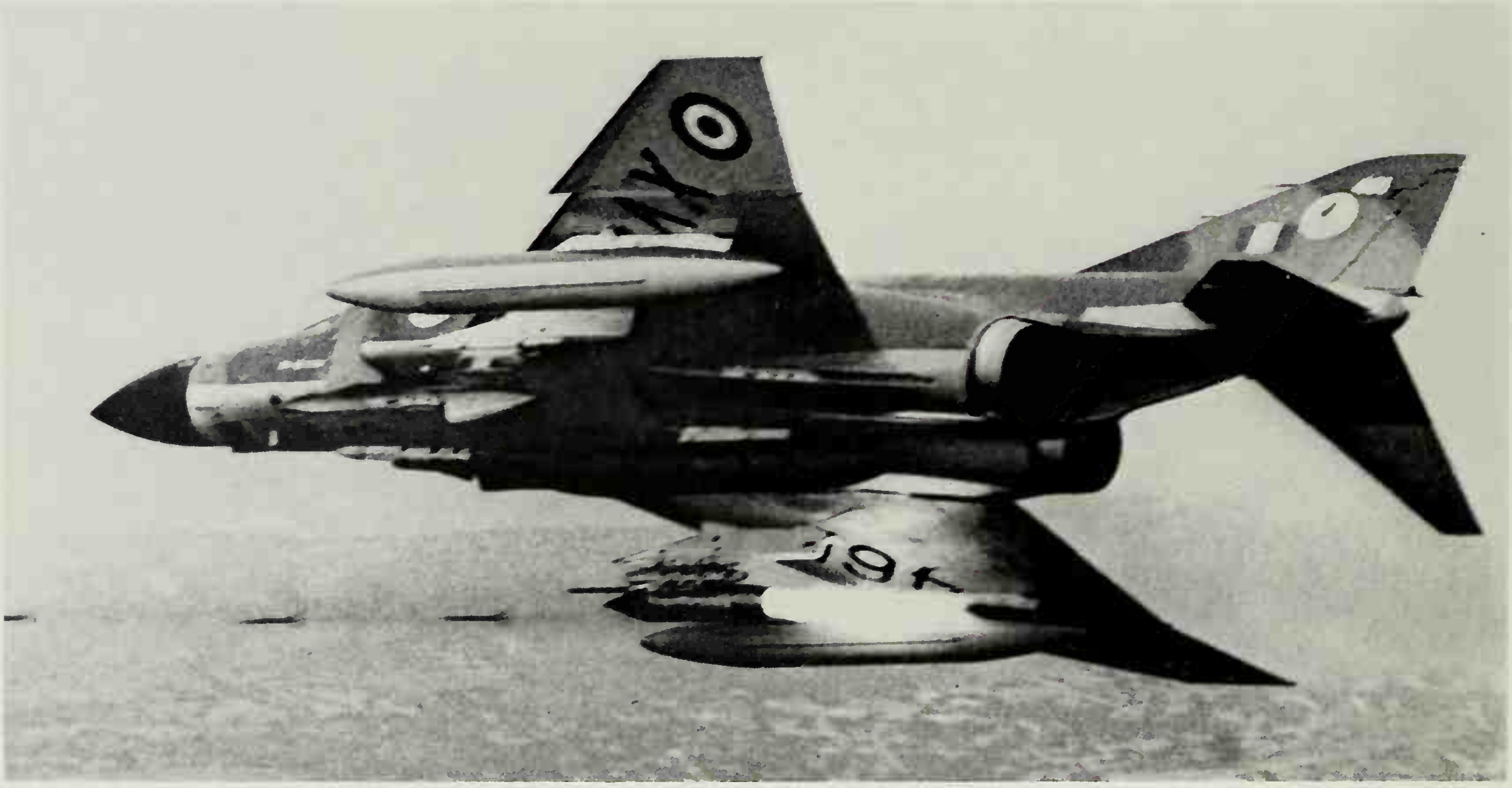
Canberra

Jet Provost Mk3

Westland Whirlwind

Jaguar

Harrier



68 mm rockets being fired from a Type M 155 rocket launcher on an RAF Phantom 1000 metres (1100 yards) from target in a 10° dive. All rockets clear the pod in 0·8 second

Rocket launchers manufactured by Thomas French & Sons Ltd in England to Matra designs (either 2-in or 68-mm) have been fitted to all these aircraft

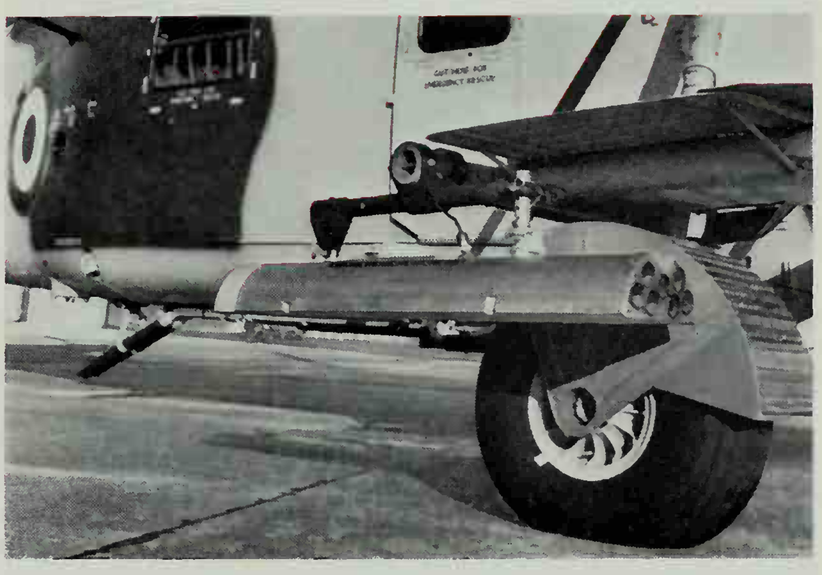
Photos are the copyright of the Ministry of Defence

Airborne rocket launchers

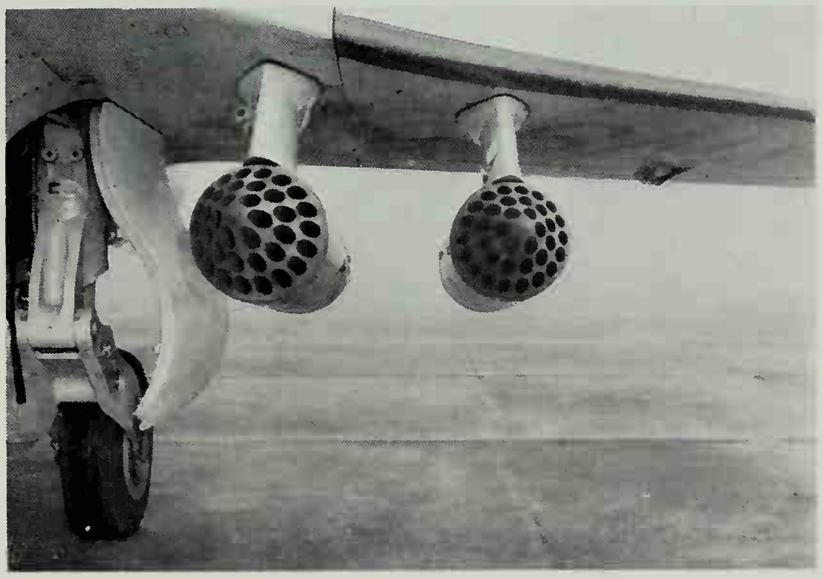
for air-to-ground attack

Manufactured in England by Thomas French & Sons Ltd to original designs of SA Engins Matra

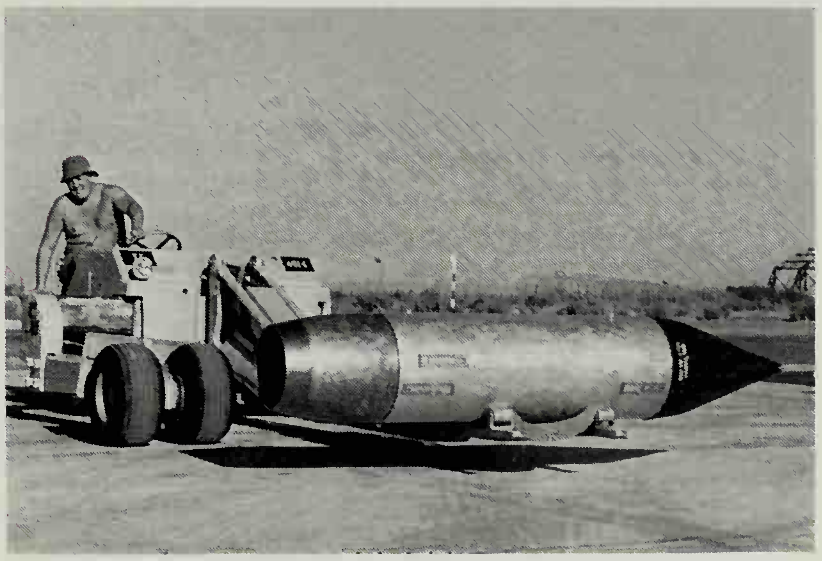
Launcher No 6 for use with 2-in rockets
Designed for use on helicopters and light aircraft to carry seven rockets which may be discharged singly or in ripple at 100 msec intervals



Launcher No 7 for use with 2-in rockets
Designed for multiple carriage on the wing stations to be compatible with the full flight envelope of most modern high-speed aircraft. The No 7 carries 36 missiles which can be fired in pairs or in ripple at 35 msec intervals

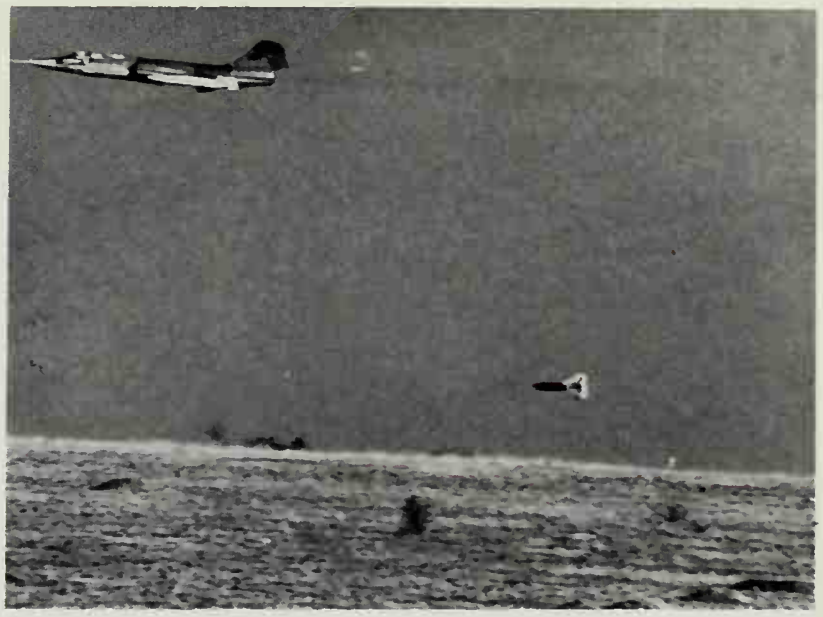


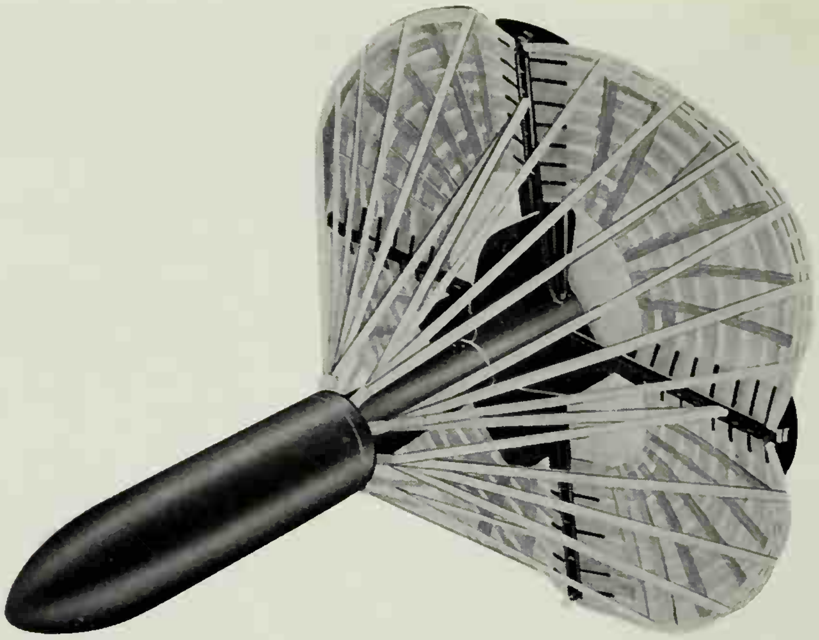
Launcher, Type M 155 for use with 68-mm rockets
Manufactured by Thomas French & Sons Ltd from an original design by Engins Matra. Designed for training and operational use to carry eighteen SNEB 68-mm rockets which can be fired singly or in ripple at 33 msec intervals

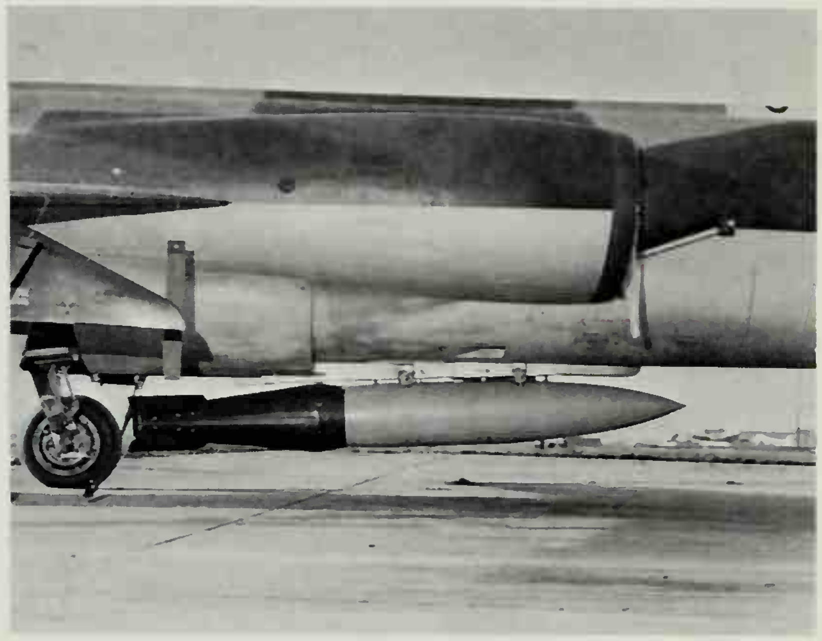


Type M 155 rocket launcher being conveyed to aircraft. Each launcher carries eighteen SNEB 68-mm rockets

THOMAS FRENCH & SONS LTD
59 St James's Street, London SW1, England
Telephone: 01-629 7101 Cables: Rufflette London SW1 Telex: 25115





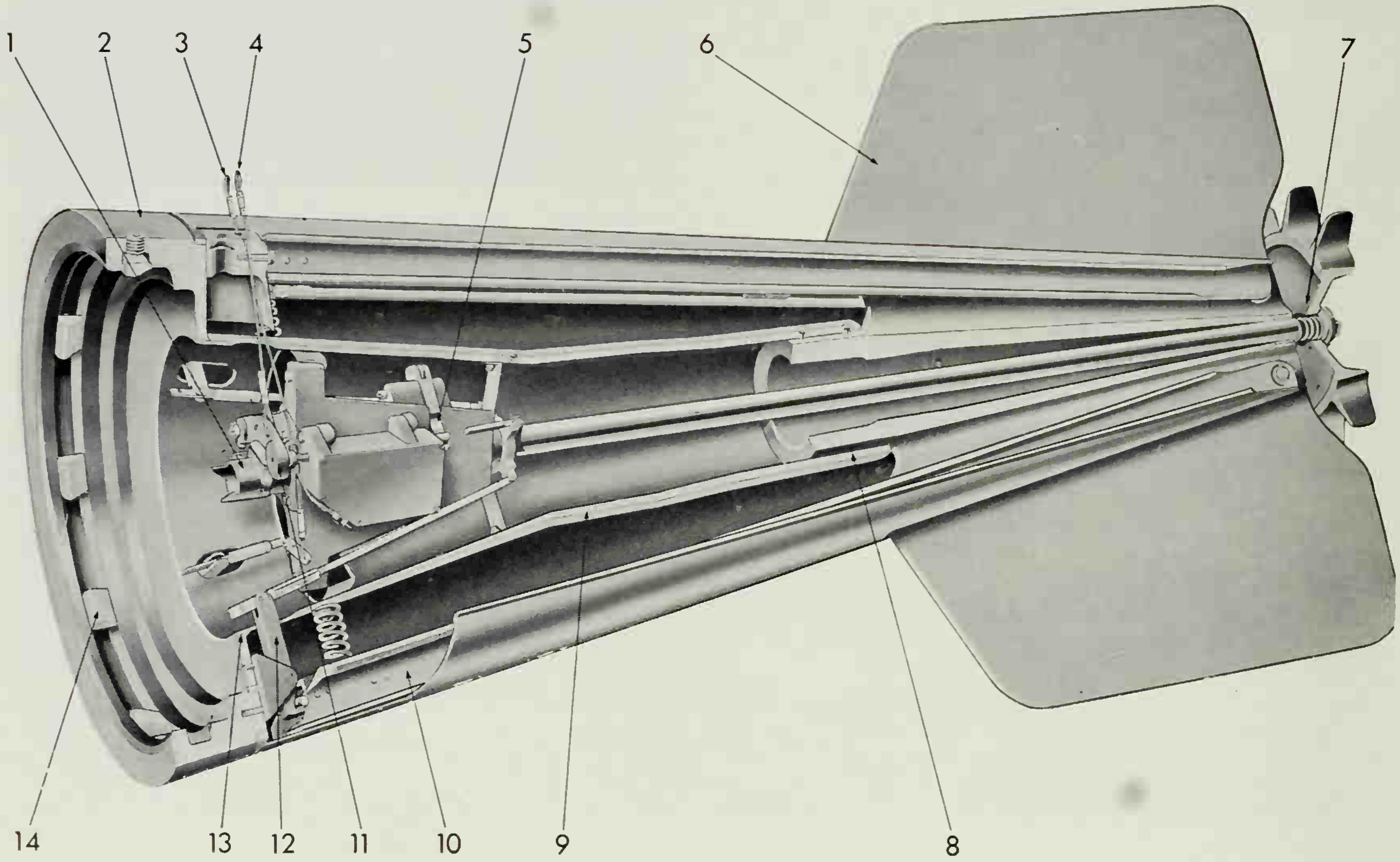


Top left: twin release of bombs with retarder system from Starfighter during a low-level attack on a defended target

Above: bomb with air-brake retarder tail in the open position, showing fabric ribbons deployed

Left: No 117 tail fitted to US Mk 83 450kg (1000lb) bomb. installed on the centre-line station of an F 104G Starfighter

Below: cut-away view of air-brake bomb retarder tail unit



1	Arming fork
2	Base ring (steel forging)
3	Lanyard (retarder timer)
4	Lanyard (arming fork lock)
5	Arm release mechanism
6	Fin assembly (one-piece casting)
7	Arming vane
8	Riveted joint (cone-to-fin assembly)
9	Central cone (flared steel tube)
10	Retarder arm
11	Arming fork lock
12	Arm release hook
13	Welded joint (cone-to-base ring)
14	Securing pads

Bomb retarder

air-brake tail unit for low-level bombing

The retarder system has been demonstrated to meet UK and NATO military requirements for safe and effective bombing in the low-level strike role. It is suitable for use with all current and projected aircraft capable of carrying bombs in the 230–450kg (500–1000lb) range (UK and US types, see table).

The equipment is designed for use in the low-level mode when attacking defended target areas where there is an operational requirement for delivering bombs at altitudes and speeds which offer the highest chances of defence penetration. Bomb retardation reduces the previously high risk of fragment damage to the aircraft to an insignificant level by ensuring a safe separation distance between aircraft and bomb at detonation. Only simple pilot-operated sighting equipment is required.

The system is incorporated in a new bomb tail unit with an air brake of composite design and a special environment-sensitive fuse.

Construction of the tail is based on a rigid body attachment ring and centre cone enclosed by four rear-hinged skin sections which are supplemented by inter-connecting ribbon fabric to form a fast-acting and reliable air brake of consistent performance. The air-brake release has a timer-controlled function initiated by a lanyard at bomb release. A second lanyard unlocks a rear-mounted fuse arming vane which, in turn, permits the fuse to monitor the bomb retardation time function and to arm or sterilise the bomb, depending on correct or incorrect conditions of release and operation.

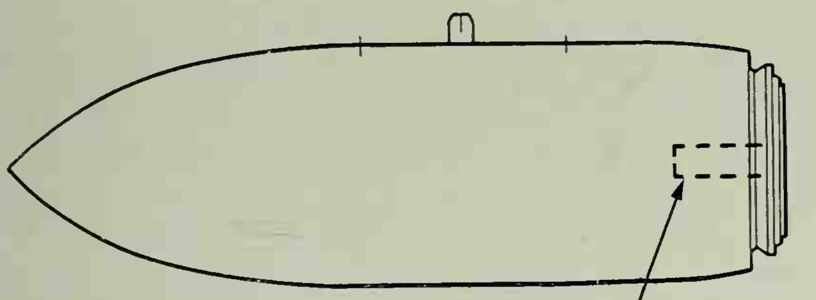
The tail is designed to fit a range of British bombs; variants are available for use with bombs of US manufacture. The system is quantity produced and in general service with the Royal Air Force.

Among the aircraft suitable for the use of retarded bomb techniques the following are typical examples: Canberra, Lightning, Hunter, Mirage, Jaguar, Vulcan, F 104 Starfighter, F 86 Sabre, Phantom and Jet Provost.

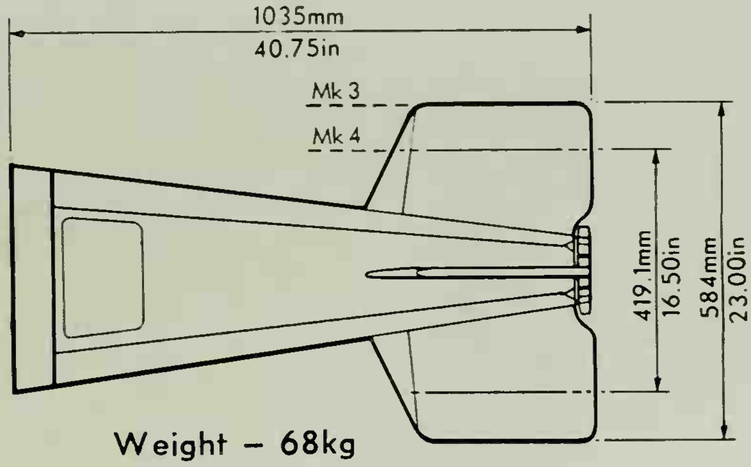
Bomb types

UK	*kg*	*lb*	*US*	*kg*	*lb*
Mk 2	453	1000	M 64	227	500
Mk 6	453	1000	M 65	453	1000
Mk 6*	453	1000	Mk 82	227	500
Mk 7*	453	1000	Mk 83	453	1000
Mk 9	453	1000	M 117	340	750
Mk 10	453	1000			
Mk 11	453	1000			
Mk 11*	453	1000			
Mk 12*	453	1000			
Mk 13–16	453	1000			
—	245	540			

453kg (1000lb) bombs



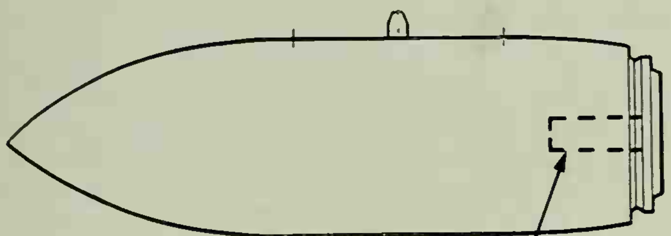
Associated fuse is fitted in rear fuse pocket



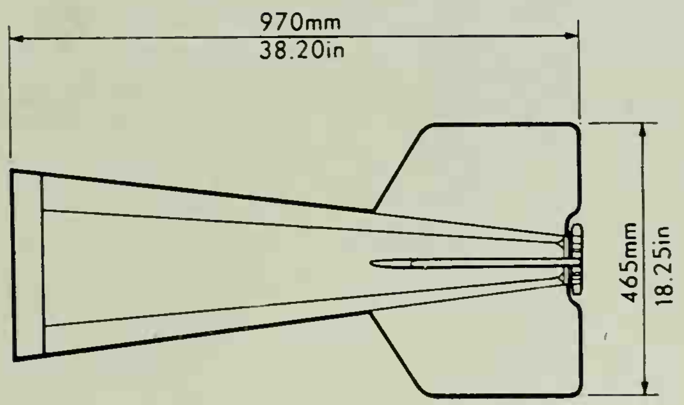
Weight – 68kg

150lb

227kg (500lb) bombs



Associated fuse is fitted in rear fuse pocket

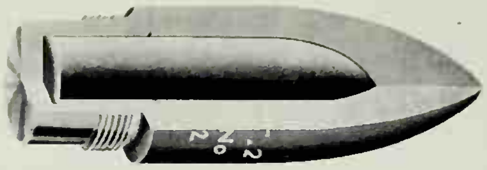


Weight – 54kg

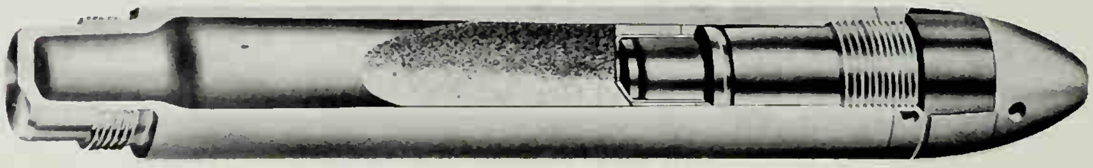
120lb

HUNTING ENGINEERING LIMITED
Defence Sales
Reddings Wood, Ampthill, Bedfordshire, England
Telephone: Ampthill 3431 Cables: Huneng Ampthill Telex: 82105

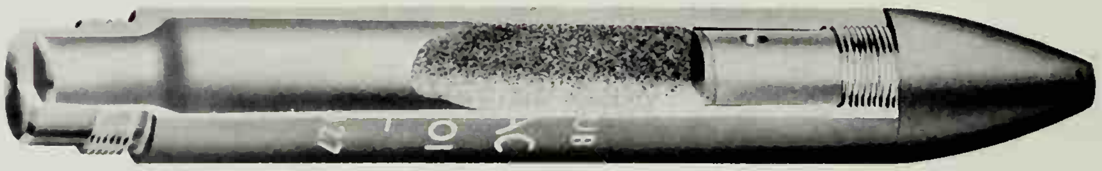
Hunting



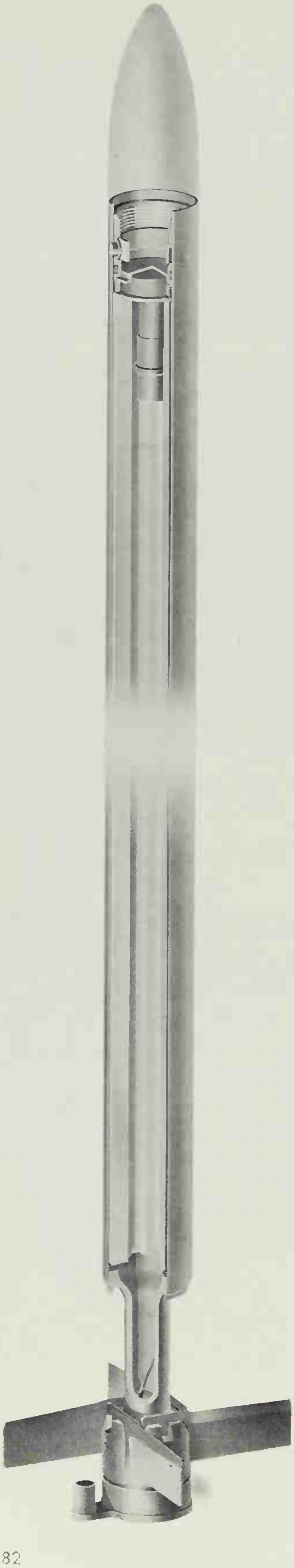
The armour-piercing rocket head weighing 1·245 kg (2·75 lb) consists of a core of tungsten carbide around which is moulded a body of resin and aluminium powder which has a high penetration capacity. The target effectiveness in terms of hole and fragment damage is comparable with that of some shaped charges of larger diameter



This head, designed for maximum blast and fragmentation effect, is a cylindrical light alloy case filled with high-explosive, detonated by a fuze No 942 screwed into its nose. The fuze incorporates a delay arming device to ensure that the rocket is at least 120 m (400 ft) from the aircraft before it is armed. The weight of the complete head is 1·475 kg (3·25 lb)



Using the same light alloy case as the high-explosive head, the practice head is filled with an inert compound and has a nose plug to represent the fuze, the complete head weighing 1·475 kg (3·25 lb)—exactly the same as the high-explosive head shown above. Attachment, as with all the rocket heads, is effected by a threaded spigot at the base of the heads



Left: 2-inch rocket with fins extended. The complete rocket is longer than shown here; the break at the middle indicates the omitted part

The rocket motor shown at the left comprises four main components: the motor tube, the propellant charge, the igniter and the fin-venturi unit.

A feature of the motor is the small ignition delay over the working temperature range, an essential feature when ripple firing is selected.

A propellant charge, occupying most of the steel motor tube, has a star-shaped hole through its entire length to permit a constant burning surface; its outer surface is inhibited by an ethyl-cellulose coating. Also the composition of the propellant is so designed that any variation in burning time in different temperature conditions is minimised.

The igniter, placed immediately on the front end of the propellant charge, combines a 'radhaz' filter for protection against premature ignition by high-power radio and radar transmission. An obturator and a spacer placed over the igniter completes the assembly which is locked in the tube by a shell ring, sealed to prevent the escape of gas. The shell ring is threaded to accept the rocket head.

The steel fin-venturi unit is screwed into the rear of the motor tube. Rectangular fins are provided on a collar at the rear of the unit and are normally restrained in the closed position by a strap until the rocket is loaded. When launched, the fins are opened about 1 metre in front of the launcher by springs and are then locked in the extended position.

An end cap, crimped to the venturi of the rocket, provides a seal for the motor and the 'radhaz' protection disc. The end cap acts as a retention device for the rocket when loaded into a launcher. It also carries a firing socket which connects with a filter and the igniter.

2-inch rocket system

for air-to-air and air-to-ground attack

The British 2-inch rocket system, now in world-wide use, has been designed by the British Government Research and Development Establishments to provide the Royal Navy and Royal Air Force with a simple, low-cost, versatile system coupled with a highly effective attack capability. Having an operational speed range extending from hovering to supersonic flight, the system is readily adaptable to any fixed or rotating-wing aircraft, including those which may be subjected to catapult take-off and arrested landing conditions.

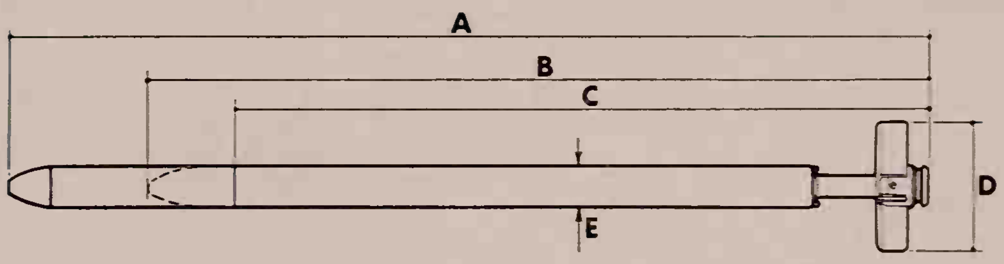
Rockets, in comparison with the complex precision-built machine guns and cannon, are simple, easily maintained, virtually recoil-less and able to deliver, with accuracy, a warhead capable of much greater destruction.

For these reasons and particularly because of its superior performance, the 2-inch rocket system is now being used as an effective weapon in the air-to-air role in addition to the conventional air-to-ground configuration. For example, the BAC Lightning employs two special 2-inch rocket pods constructed integral with the aircraft fuselage as its conventional weapon system, secondary to its guided missiles.

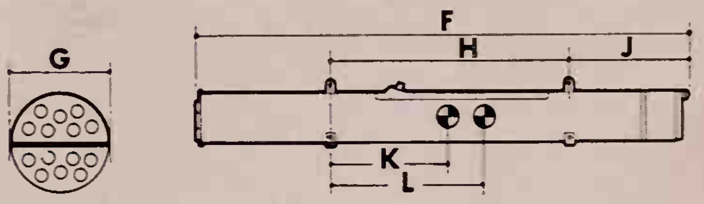
Any conventional aircraft using a simple reflector or angular velocity gunsight can employ this modern technique by fitting 2-inch multiple launchers to the underwing pylons or strong points.

Two standard launcher units (the No 6 for helicopters and light aircraft, and the No 7 for most other aircraft) are also available.

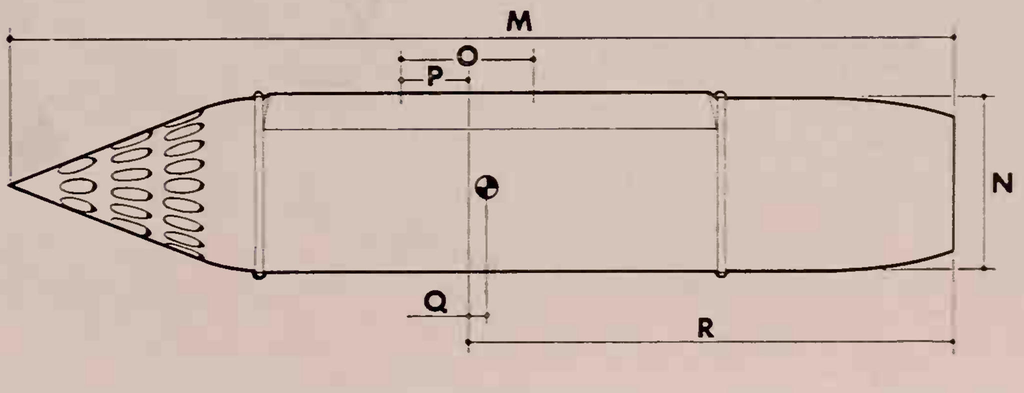
Rocket
Dimension:
A 121·90 cm (48·00 in)
B 100·25 cm (39·40 in)
C 88·90 cm (35·00 in)
D 17·00 cm (6·70 in)
E 5·10 cm (2·00 in)
Weight with HE head or practice head:
4·55 kg (10·02 lb)
Weight with armour-piercing head:
4·32 kg (9·52 lb)



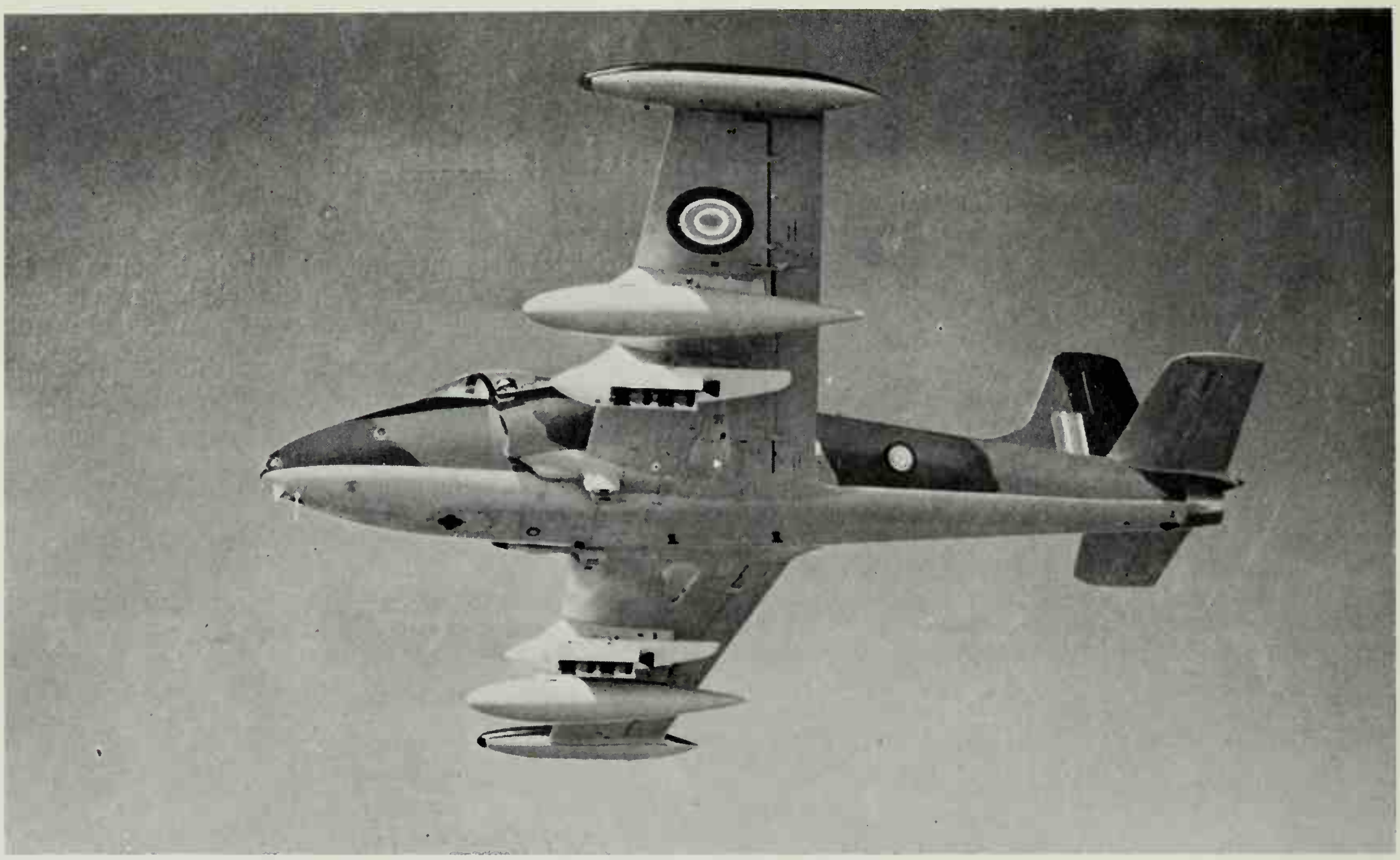
Launcher No 6
Dimension:
F 130·65 cm (51·44 in)
G 28·85 cm (11·36 in)
H 64·40 cm (25·36 in)
J 31·57 cm (12·43 in)
K 31·75 cm (12·50 in) (loaded)
L 41·00 cm (16·15 in) (fired)
Weight, loaded: 49·45 kg (109 lb)
Weight, fired: 17·69 kg (39 lb)



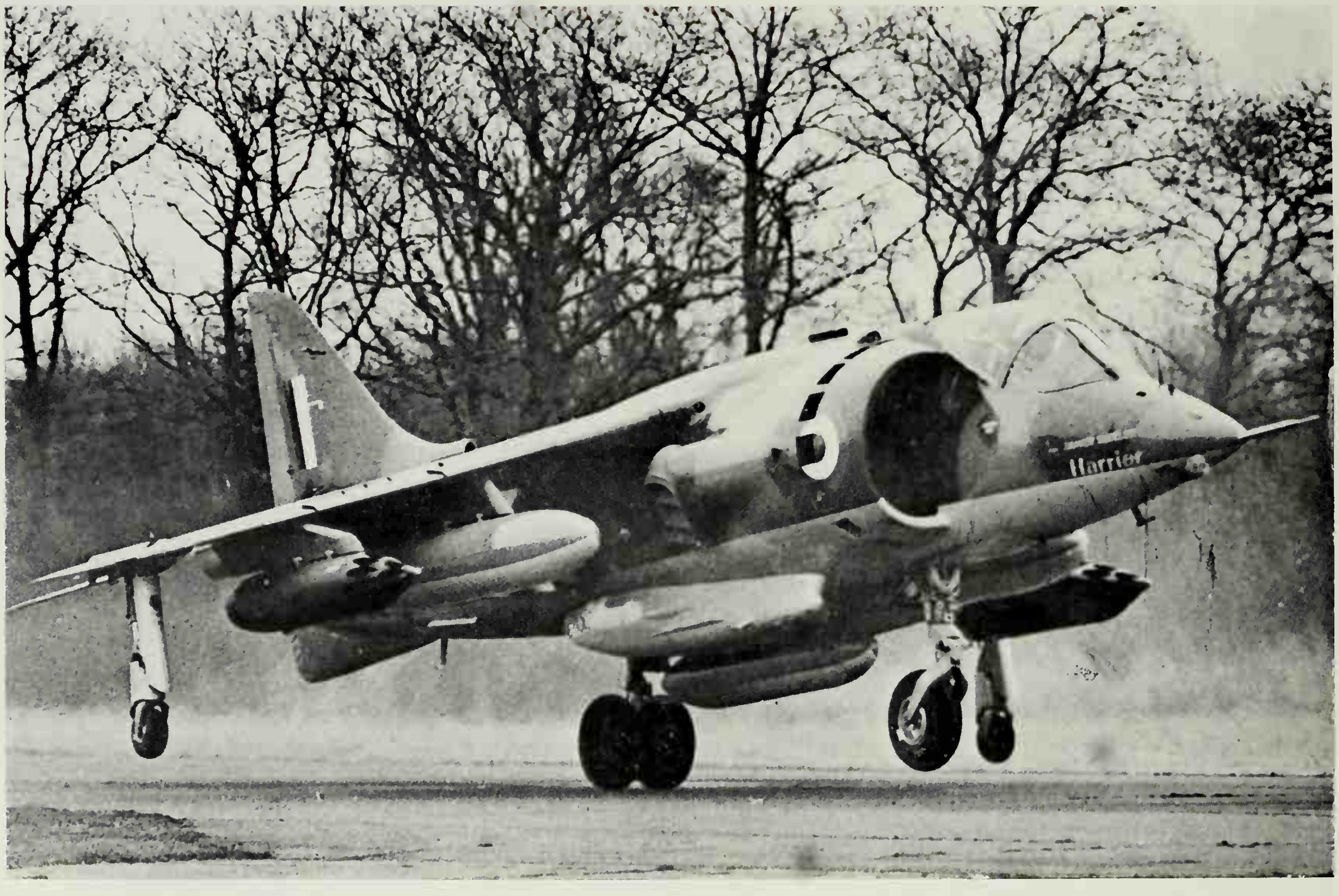
Launcher No 7
Dimension:
M 254·00 cm (100·00 in)
N 46·87 cm (18·06 in)
O 35·56 cm (14·00 in)
P 17·78 cm (7·00 in)
Q 4·52 cm (1·78 in)
R 132·80 cm (52·30 in)
Weight, loaded: 260·37 kg (574 lb)
Weight, fired: 97·53 kg (215 lb)



MINISTRY OF TECHNOLOGY
Department EIR 2
Stuart House, 23–25 Soho Square, London W1, England
Telephone: 01-437 9288 Cables: Mintec London Telex Telex: 22241



The British Aircraft Corporation Jet Provost trainer aircraft is seen here equipped with 1·8 kg (4 lb) retarded practice bombs. Now in production for Royal Navy and Royal Air Force use, the main advantages of the bomb are: light weight combined with simplicity and low cost, a high degree of safety, and suitability for world-wide transportation storage and handling



The Hawker Siddeley Harrier shown here in vertical take-off posture is equipped with 455-litre (100-gal) long-range fuel tanks which provide a substantial increase in the operational range of this unique aircraft. Rolls-Royce fibre-reinforced composite tanks of varying capacities are standard equipment on this and many other Royal Air Force and Royal Navy strike aircraft

Aircraft stores

of fibre-reinforced composites

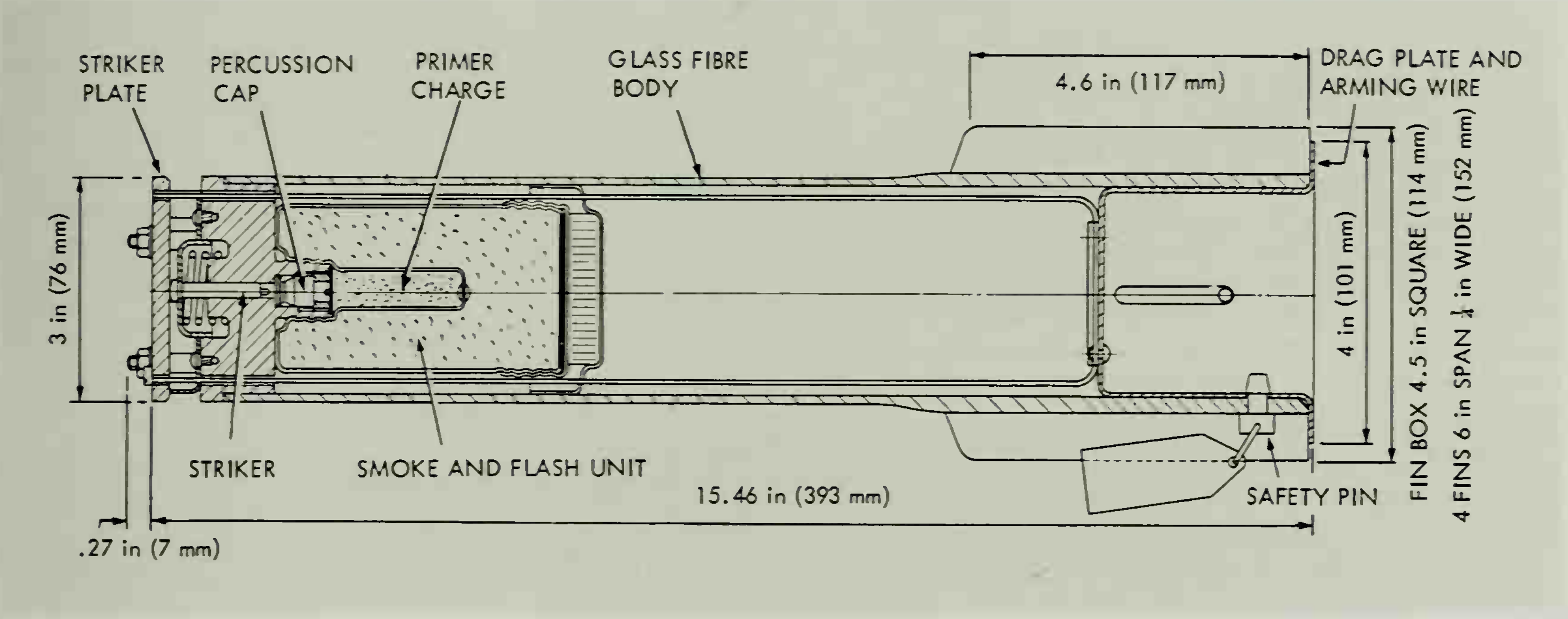
Retarded practice bomb

The 1·8 kg (4 lb) retarded practice bomb has been developed for the Royal Navy and the Royal Air Force for aircrew training. It consists of a nose and body which house the striker, smoke and flash unit. It is suitable for flight carriage at speeds in excess of 1110 km/h (600 knots) at sea level and for release at heights down to 15 m (50 ft) with reserve strength for carriage and release at speeds up to 1480 km/h (800 knots) indicated air speed.

The body is a finned glassfibre-reinforced plastics cylinder with an internal support diaphragm for the smoke and flash unit and a sliding drag-plate closure at the rear to actuate the arming mechanism.

The smoke and flash unit is an aluminium alloy container with an internal pocket for the primer charge and a threaded orifice which accepts the main filling.

The nose comprises a striker plate, striker assembly and 9-mm percussion cartridge with gunpowder boost. A safety mechanism prevents bomb arming before release. Shear wires prevent the bomb from functioning until it impacts.


STRIKER PLATE
PERCUSSION CAP
PRIMER CHARGE
GLASS FIBRE BODY
4.6 in (117 mm)
DRAG PLATE AND ARMING WIRE
3 in (76 mm)
4 in (101 mm)
FIN BOX 4.5 in SQUARE (114 mm)
4 FINS 6 in SPAN ⅛ in WIDE (152 mm)
STRIKER
SMOKE AND FLASH UNIT
15.46 in (393 mm)
SAFETY PIN
.27 in (7 mm)

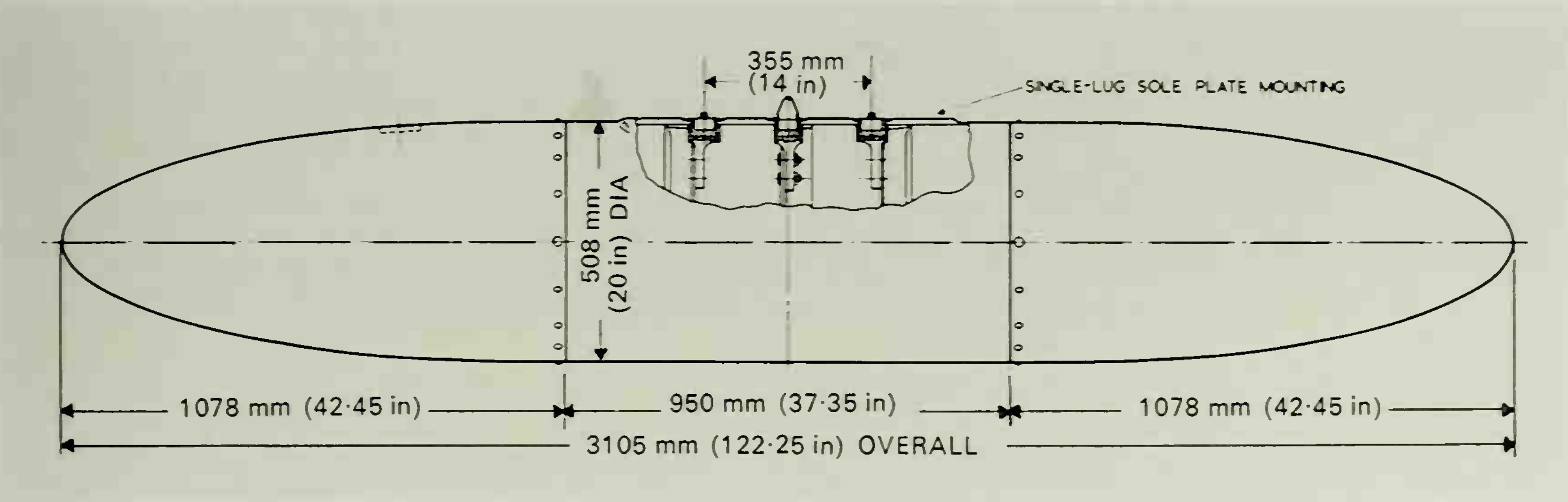
Long-range fuel tanks

Special design and manufacturing methods were developed to produce asbestos-reinforced phenolic fuel tanks. Their mechanical and aerodynamic performance has proved to be superior to that of equivalent metal tanks, due to the extremely accurate shell contour. Tanks are in current production for the Royal Navy and the Royal Air Force, and are also manufactured under licence in various countries in Europe.

The standard range of tanks so far in production or being developed have the following capacities: 227, 340, 455, 682, 909, 1364 and 2273 litres (50, 75, 100, 150, 200, 300 and 500 gal).

Rolls-Royce tanks are made in three parts: nose shell, centre section with attachment points, and tail shell.

The centre section is a plain cylinder so that alternative capacities can be obtained by varying its length. This considerably simplifies manufacture and storage. The illustration shows single-lug mounting but twin-lug or special mountings can be fitted.

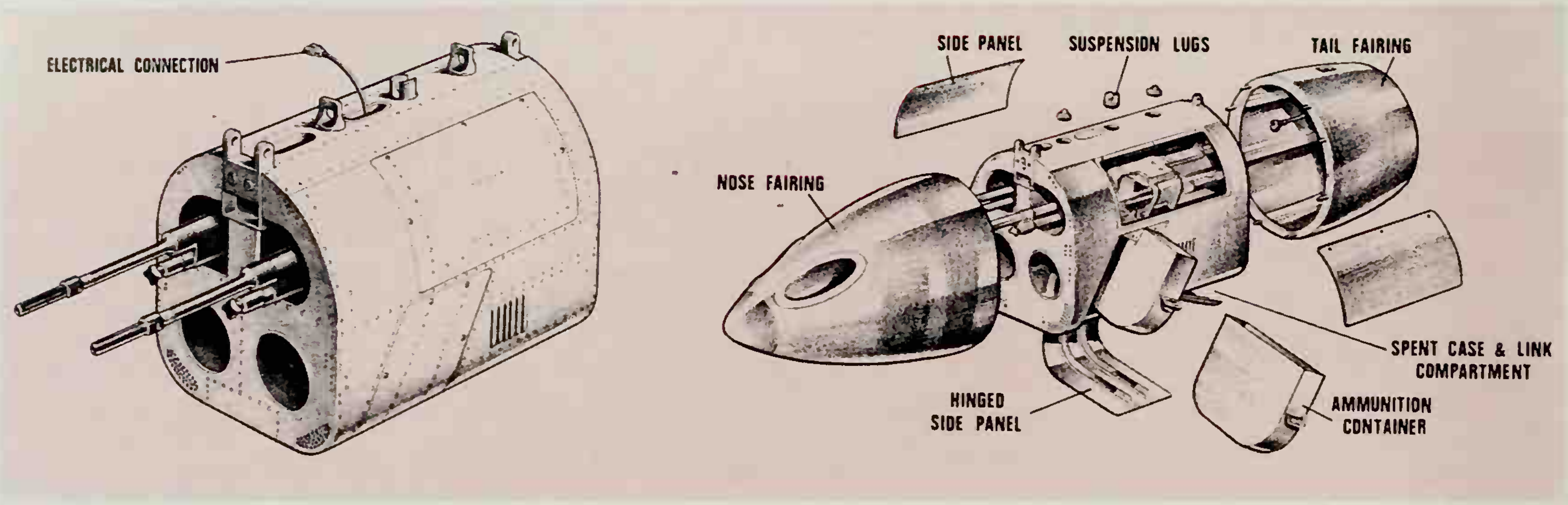

355 mm (14 in)
SINGLE-LUG SOLE PLATE MOUNTING
508 mm (20 in) DIA
1078 mm (42·45 in)
950 mm (37·35 in)
1078 mm (42·45 in)
3105 mm (122·25 in) OVERALL

ROLLS-ROYCE (COMPOSITE MATERIALS) LTD
Avonmouth Road, Avonmouth, Bristol, BS11 9DU, England
Telephone: Avonmouth 4821 Cables: Rolcom Avonmouth Telex: 44207

ROLLS
RR
ROYCE

Machine gun pod

and HE bomb tail units



The Universal Twin 7·62 mm Machine Gun Pod is particularly suitable for use on helicopters to provide heavy suppressive fire and on the lighter fixed-wing fighters and reconnaissance aircraft for ground attack and counter-insurgency roles. The pod is also easily fitted in emergency to comparable types of civil aircraft. For carriage on helicopters, the centre section only of the pod may be used. On fixed-wing aircraft, the increased flying speed requires the addition of the nose and tail fairings.

The pod is a self-contained unit and is fitted with attachments suitable for most aircraft suspension arrangements.

The two guns are NATO-approved air versions of the standard FN.L7A1 machine gun and fire standard NATO 7·62 mm ammunition. Adjustments provide for individual harmonisation of each gun in elevation and azimuth.

Machine gun pod

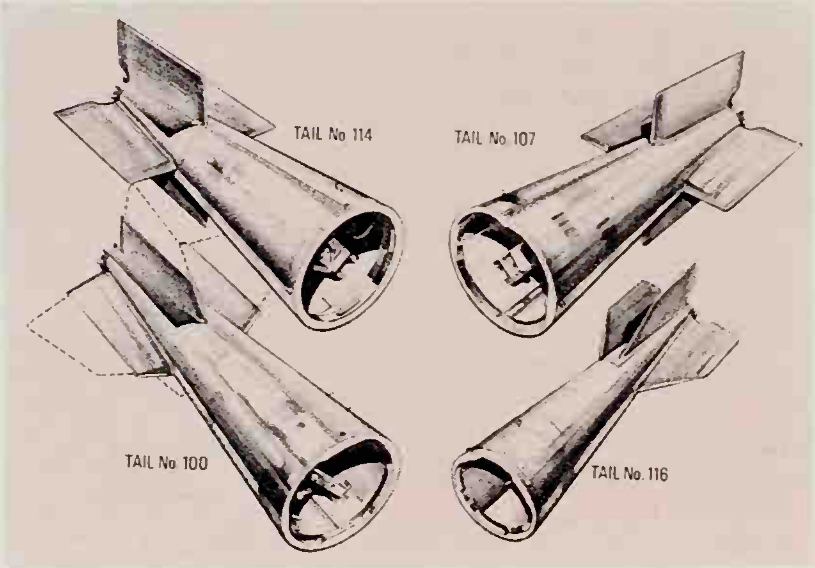
Specification

Dimensions and weights

Pod height: 464 mm (18·25 in)
Pod width: 420 mm (16·54 in)
Pod length:
  Helicopter version—pod only: 670 mm (26·36 in)
  Helicopter version—with guns: 1053 mm (41·45 in)
  Fixed-wing version—faired: 1845 mm (72·63 in)
Weight, with guns and ammunition:
  Helicopter version: 72·6 kg (160 lb)
  Fixed-wing version: 83·0 kg (183 lb)

Performance

Rate of fire per gun: 850/950 rounds/minute
Ammunition capacity: 500 rounds/gun
Max carriage speed: 1158 km/h (625 knots)



HE bomb tails

The tails for aircraft HE bombs shown have been fully developed and are of proved reliability and in extensive current Service use.

The three standard bomb tails (Nos. 114, 107 and 100) are designed for use with 454 kg (1000 lb) high-explosive bombs Mk 6, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, and 19. (Tail No. 100 has retractable fins for use where carriage clearance is restricted.)

The standard tail No. 116 is used with the 245 kg (540 lb) high-explosive bomb Mk 1. The four tails are provided with mechanisms which permit arming of the fuses or pistols fitted to the bombs only after the bombs are released from the aircraft. In addition provision is made for the optional fitting of one or other of two delayed arming devices which retard arming for $3\frac{1}{4}$ and $8\frac{1}{2}$ seconds respectively after release.

Full specifications are available on request.

PORTSMOUTH AVIATION LIMITED
The Airport, Portsmouth, Hampshire, PO3 5PF, England
Telephone: Portsmouth 62251   Cables: Portavia Portsmouth   Telex: 86205

Ammunition

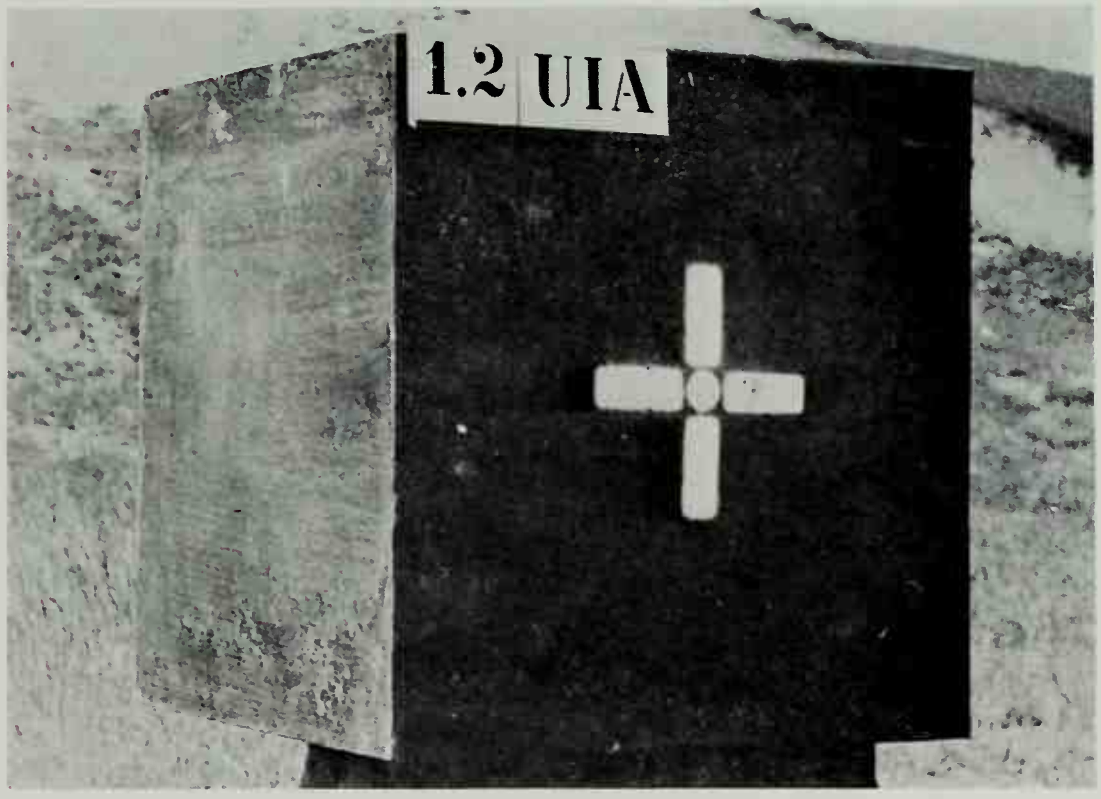
for Aden aircraft cannons

Hispano Suiza produces the following types of ammunition for Aden-type aircraft cannon to meet in full the tactical requirements of modern air forces.

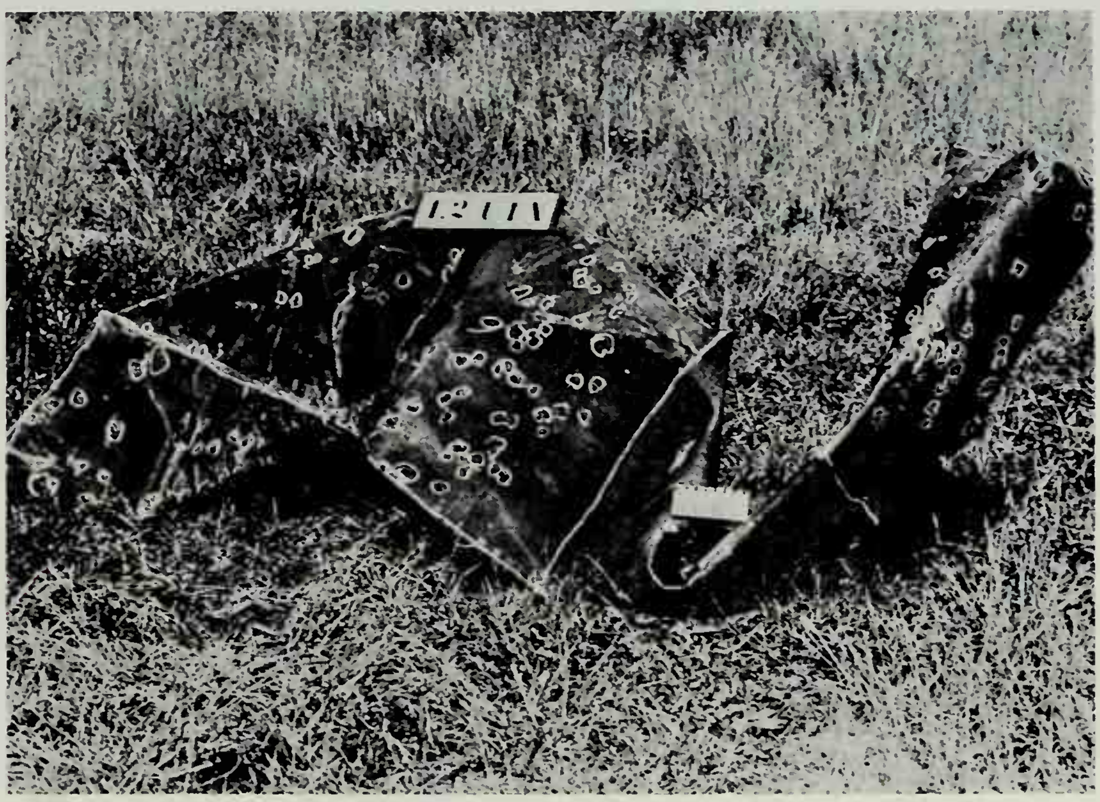
Practice: Type HE-P
This is an inert practice shell which has the same ballistic properties as a live shell.

Armour-piercing: Type APHEI
A semi-armour-piercing incendiary shell with self-destruction, used as a general-purpose shell.

High-explosive: Type HEI
An incendiary explosive shell with self-destruction and great blast effect.



Before firing: target cube with 1-metre sides welded from 1 mm thick steel sheet



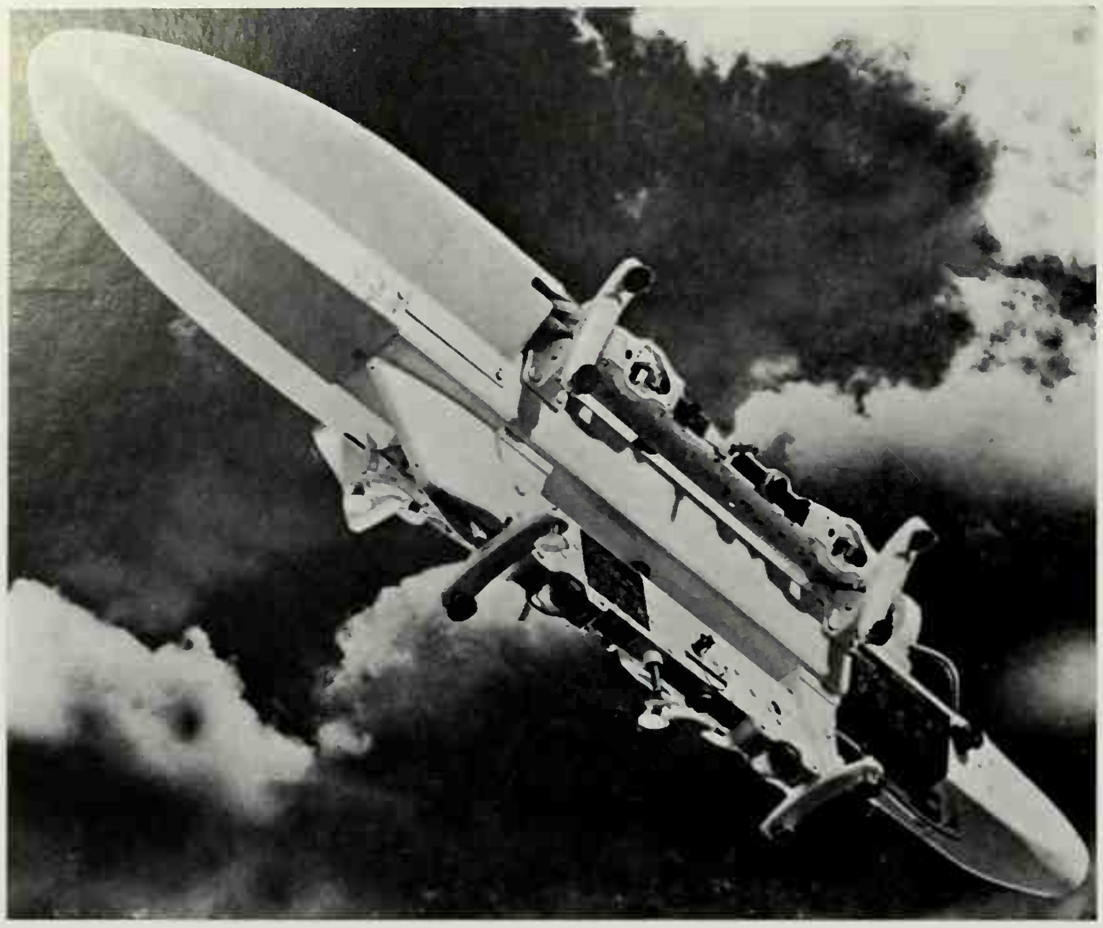
After firing: this is the destructive effect of Type HEI (UIA) ammunition

A wide range of other ammunition of all types, as well as various guns, are made by this company; brief details of some guns are given elsewhere in this Catalogue and full particulars are available on request.

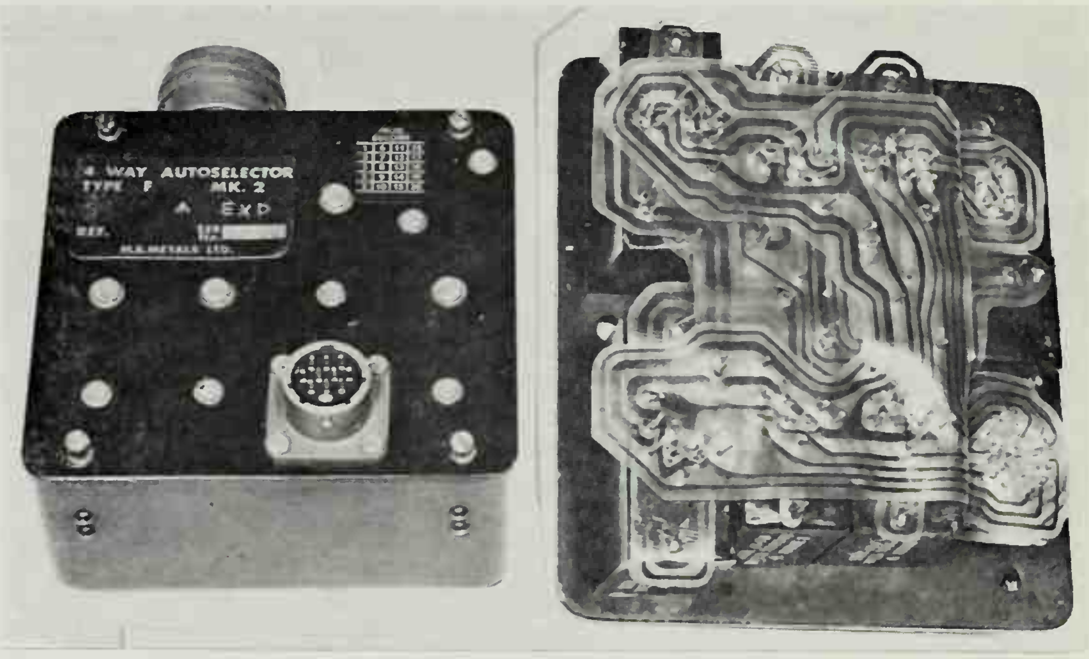
Since 1939 the British Manufacture and Research Co Ltd has been the major supplier within the UK of all types of 20 mm and 30 mm ammunition; further details are available from the company.
Details of HSS 831L 30 mm ammunition are given elsewhere in this Catalogue.

BRITISH MANUFACTURE AND RESEARCH CO LTD
Springfield Road, Grantham, Lincolnshire, England
Telephone: Grantham 2101 Cables: Marco Telex Grantham Telex: 37635

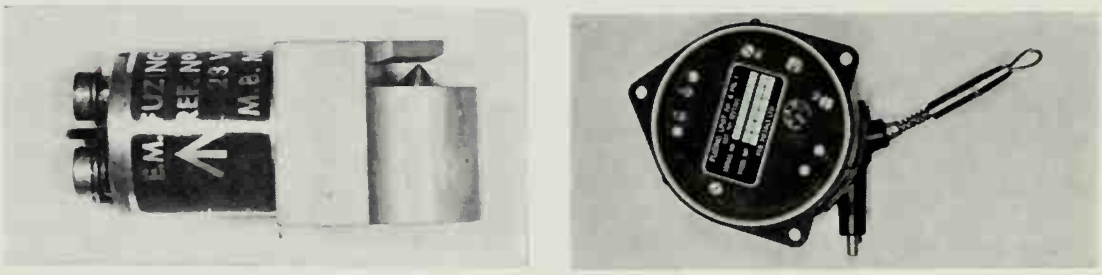
A MEMBER OF THE
HISPANO SUIZA
ARMAMENTS GROUP



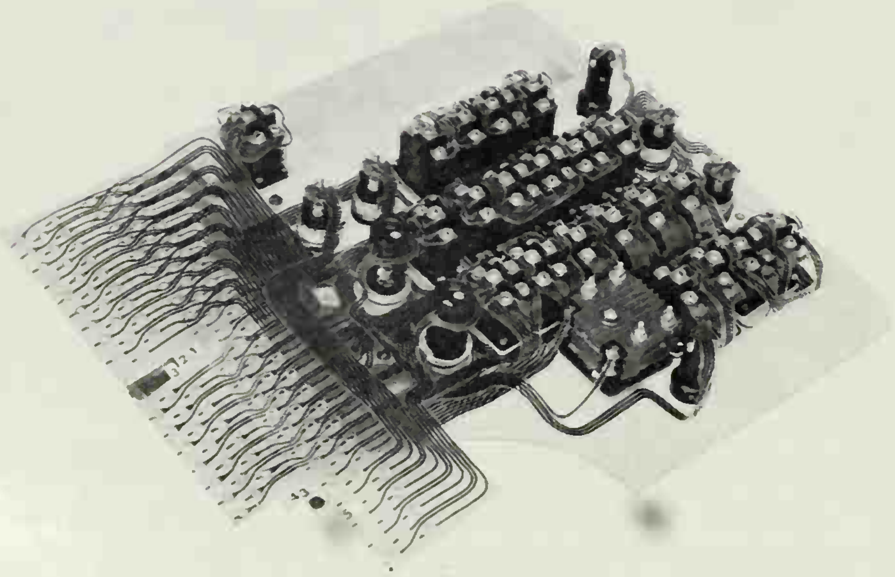
Type 121X ERU single-cartridge twin-ejector release unit for airborne bombs and rockets, one of a wide range made by MB Metals Ltd



The Type F four-way auto-selector (far left) distributes pulses in aircraft or weapon carriage systems. Internal wiring (left) is of the flexible film wire type



Electromechanical fusing units No 5 Mk 2 (far left) and No 4 Mk 1 (left) for fusing stores when dropped from weapon carrier



Flexible printed circuit panel using film wire. This panel forms part of the dashboard control circuits of a Westland helicopter

Weapon mountings

for aircraft

Airborne weapons carriage systems

The 119 ERU is a twin-cartridge twin-ejector release unit. It can carry a wide variety of stores including SNEB and LAU rocket launchers, 454 kg (1000 lb) ballistic and retarded bombs and any store in the 454 kg (1000 lb) nominal weight class up to 452 mm (18 in) diameter.

The TER 119X consists of a main beam fitted with three 119 ERU units together with a built-in individualised electrical system. A 12-pin snatch-connector provides the complete input requirements from the aircraft.

Facilities exist to incorporate rocket firing release of flares, nose (VT) and tail (electrical) fusing units and a stores-sensing switch to the basic equipment.

The 121X ERU is a single-cartridge twin-ejector release unit. It can carry a wide range of stores including SNEB and LAU rocket launchers, 454 kg (1000 lb) ballistic and retarded bombs and any store in the 454 kg (1000 lb) nominal weight class up to 452 mm (18 in) diameter.

It is also supplied fitted to a main beam as described for the TER 119X mentioned above.

Stores distribution systems

Type 'F' auto-selectors may be used for distributing pulses around weapon carriage systems, or through the aircraft system. These designs are available for distributing pulses two, four or six ways, but other ways can be provided. The distributors may be of the type which, when supplied with a train of pulses, continues to distribute it round the system, constantly repeating the distribution pattern. Alternatively, they may be of the type which goes through one distribution sequence and then stops, irrespective of the number of additional pulses supplied to it. The basic auto-selector unit consists of a latching relay with a 5A switching capability, and an associated charging/discharge circuit which ensures that the relay is switched when the operating pulse is removed. The complete module is a welded assembly and the complete unit is encapsulated in a resin to produce a rugged construction. The auto-selector is made up from a number of basic units. Each unit is rigidly secured to a mounting plate, and the wiring between the units is formed by film wire. This is a flexible printed circuit system which ensures that the connections made between modules must always be identical and correct. This is achieved by fitting the printed circuit directly over the projecting wires to which it is connected.

The No 5 Mk 2 fusing unit is an electromechanical device. It consists of a housing assembly, solenoid assembly, plunger and spring assembly and is used to fuse the stores when dropped from the weapon carrier. The fusing unit is electromechanically operated, and is used in conjunction with a fusing cable attached to the store. The weight of the fusing unit is 85 g (3 oz). It operates on a voltage of 21–29 V dc.

The No 4 Mk 1 fusing unit is also electromechanically operated, but incorporates the fusing cable which is automatically retracted after operation. It is standard RAF equipment on several bomb carriers.

Film wiring techniques

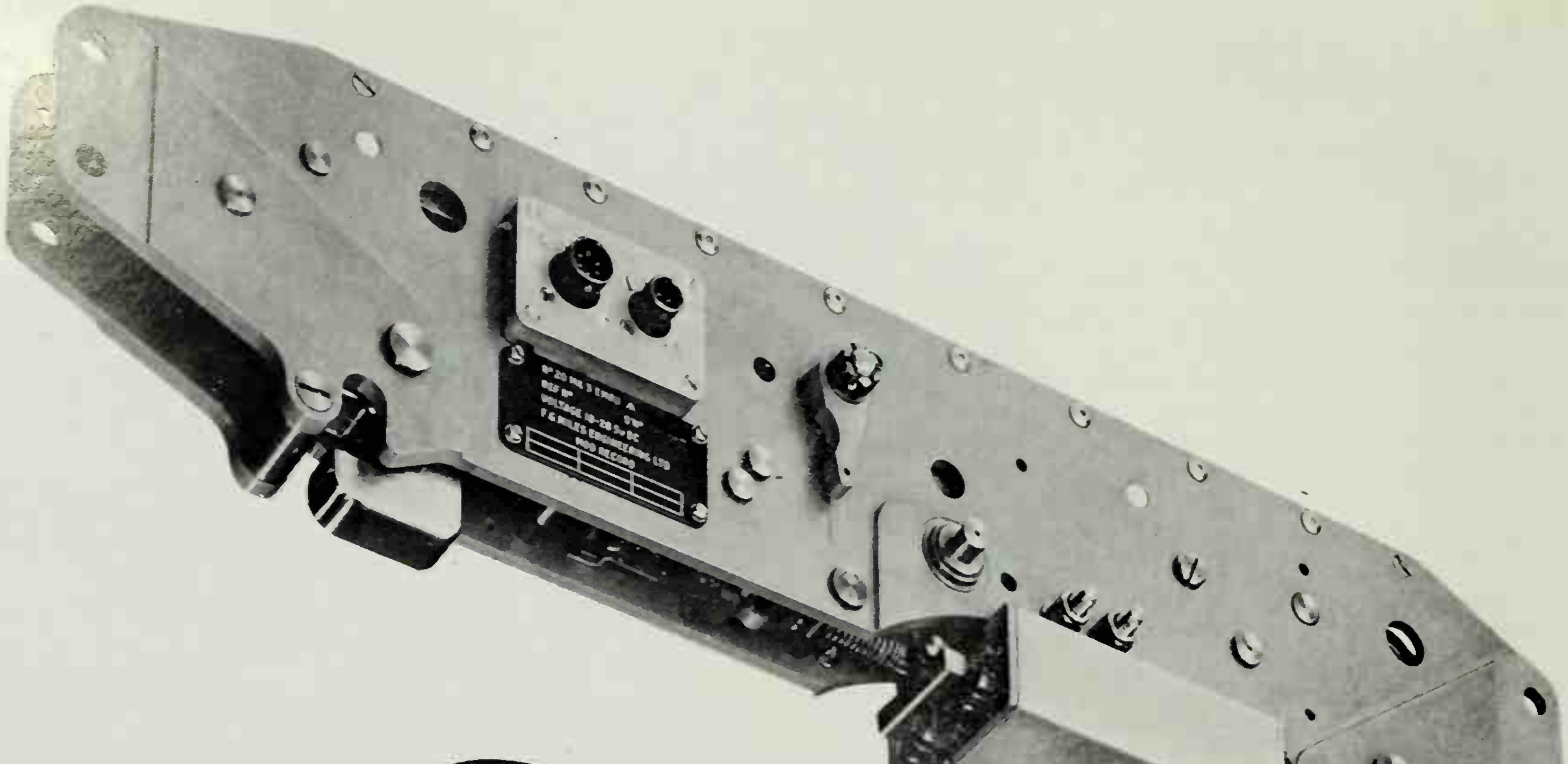
The company has been the product leader in Europe during the past eight years for the design and manufacture of flexible printed wiring. Applications assist space and weight savings for aircraft wiring systems, lighting and power, instrument panels and black-box equipment.

Environmental approved test house

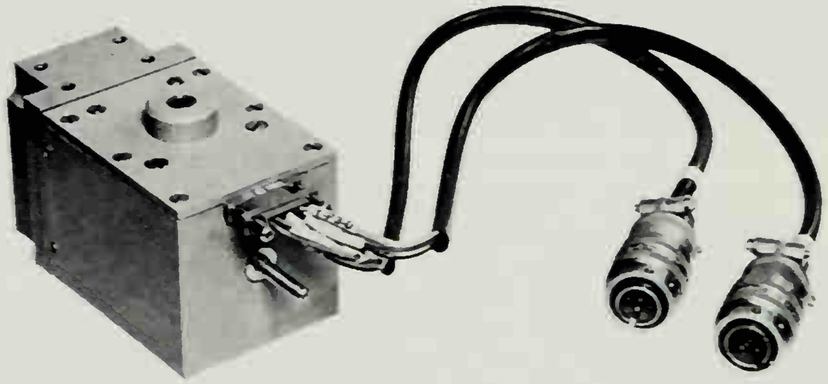
The company undertakes investigation and proof-testing of equipment for governments and other contractors, particularly relating to the aerospace industry.

MB METALS LIMITED
Armament Division
Victoria Road, Portslade, Sussex, BN4 1YH, England
Telephone: Brighton 46981 Cables: Metals Portslade Telex: 87311

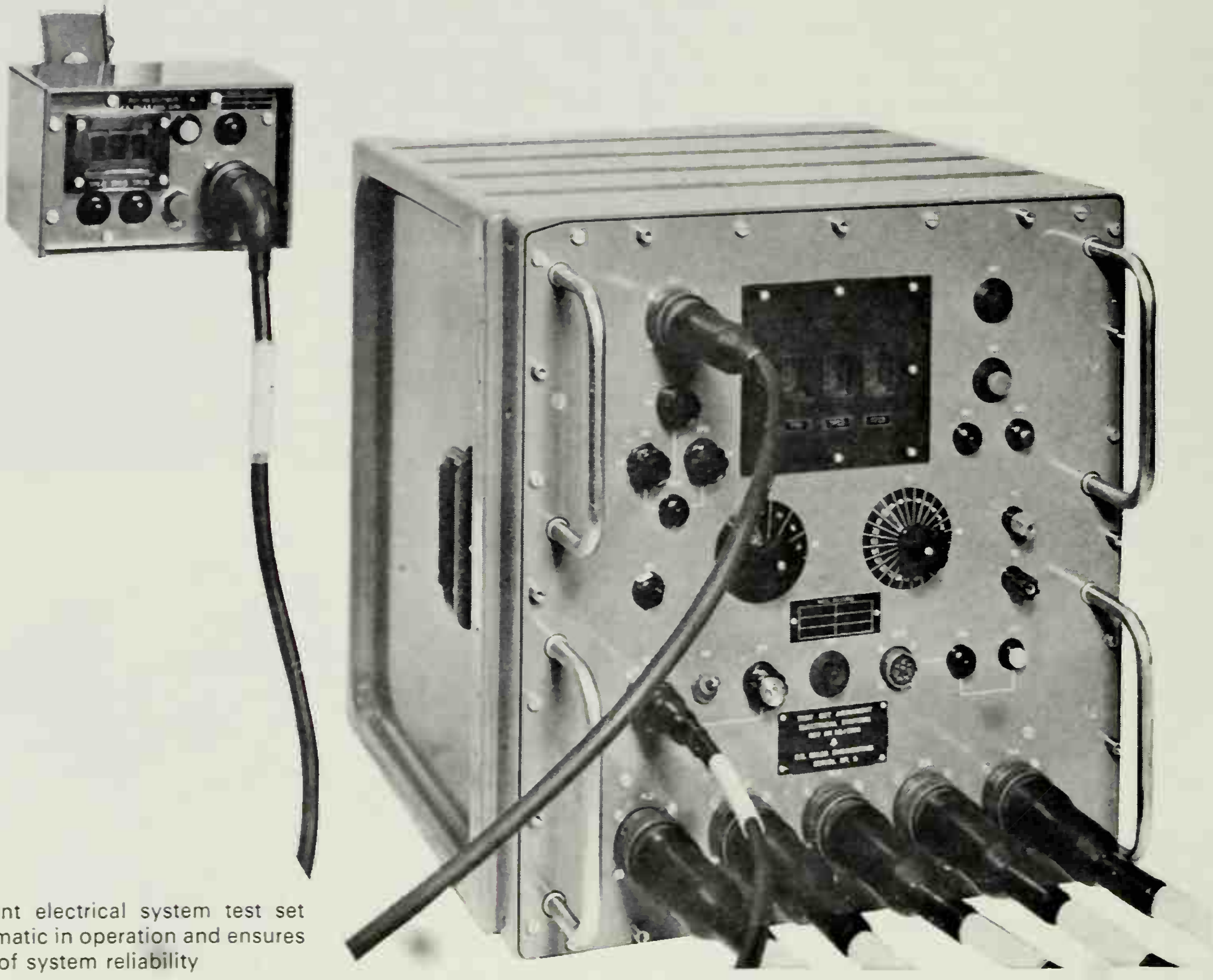
MBM



The Miles electro-magnetic release unit EMRU No 20 Mk 4; the Mk 3 unit is identical in design but has an actuator fitted



A Miles MAL 19 actuator for the Miles electro-magnetic weapon release unit



The armament electrical system test set is semi-automatic in operation and ensures a high level of system reliability

Weapon release

and weapon system check-out equipment

Release units

The free-fall electro-magnetic release units (EMRU) developed by Miles are in service with both the Royal Navy and Royal Air Force.

All units, which operate from a nominal 24 V dc (18–28·5 V) supply, are interchangeable and employ the standard NATO 14-inch (355·6 mm) twin-hook suspension. They operate satisfactorily over the temperature range from −60°C to +150°C and are designed for bomb bay or pylon-mounting, with safety and reliability as a prime requirement.

The EMRUs No 20 Mk 1 and Mk 2 are basically similar except that the Mk 1 is fitted with a separate bomb release safety lock (BRSL) in the form of a Miles MAL 12 actuator. Both units are designed to carry a 680 kg (1500 lb) weapon under full service manoeuvre conditions.

EMRUs No 20 Mk 3 and Mk 4 are again basically similar except that the Mk 3 uses the Miles MAL 19 lightweight actuator as a BRSL. These units carry a 454 kg (1000 lb) weapon and are designed to a low weight, so that they are especially suitable for helicopter use.

Specification

EMRU No 20
Dimensions: length 542·5 mm (21·38 in); width 71·0 mm (2·8 in); depth 137·5 mm (5·42 in)
Weight: EMRU No 20 Mk 2 8·0 kg (17·5 lb); EMRU No 20 Mk 4 4·5 kg (10·0 lb)
Load: Mk 1 and Mk 2, normal store 680 kg (1500 lb), proof 15 420 kg (34 000 lb)
Mk 3 and Mk 4, normal store 454 kg (1000 lb), proof 7550 kg (16 600 lb)

Actuator MAL 12
Dimensions: length 180·0 mm (7·08 in); width 158·0 mm (6·22 in); depth 152·5 mm (6·00 in)
Weight: 4·75 kg (10·5 lb)
Stroke: 32·0 mm (1·25 in)

Actuator MAL 19
Dimensions: length 92·5 mm (3·64 in); width 52·0 mm (2·06 in); depth 51·0 mm (2·00 in)
Weight: 0·65 kg (1·44 lb)
Stroke: Mk 1 7·87 mm (0·31 in); Mk 2 16·5 mm (0·65 in)

Armament electrical systems test set

Weapon systems of the modern aircraft of today are so complex that traditional means of checking circuitry are no longer either sufficiently accurate or sufficiently rapid to be acceptable. With this background, the armament electrical systems test set was designed as the first of a new generation of weapon test sets. With this set, one man is capable of checking a complete aircraft weapons system in just over thirty minutes, including connecting-up time.

The set is capable of quickly and accurately checking a large number of parameters simultaneously by storing information. The unit is portable and is provided with leads for connection to the appropriate points on the aircraft. It is operated from a remote control box, used by the operator sitting in the aircraft cockpit, and indicates the result in a pass/fail form. The system is semi-automatic in operation and indicates the location and nature of any fault. A self-check facility is provided.

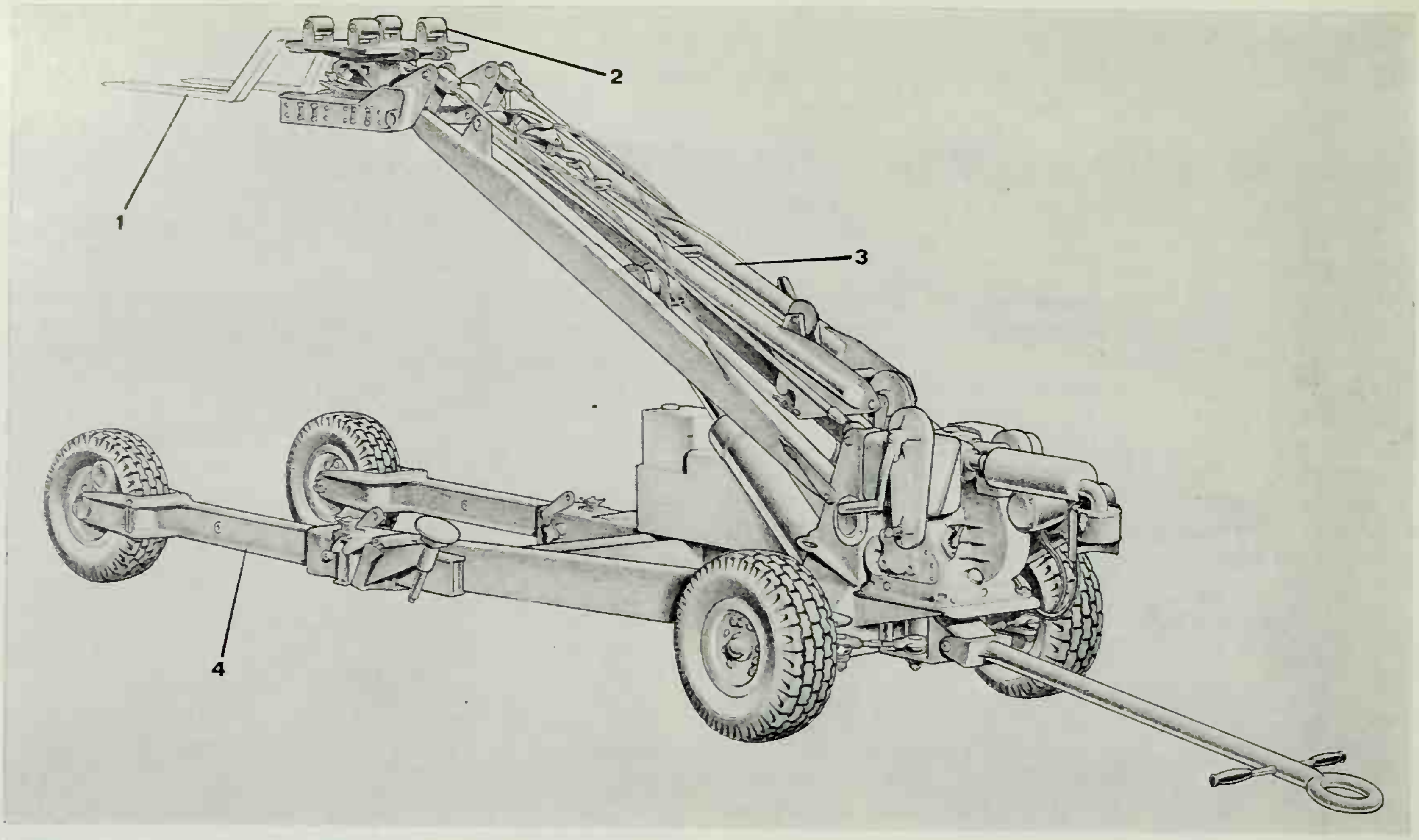
Due to the high level of checking, aircraft serviceability levels are improved by use of the unit.

Specification

Size: 395 × 395 × 436 mm (15·5 × 15·5 × 17·5 in)
Weight: 27·2 kg (60 lb) not including cables
Power supply: 115 V, 400 Hz, 350 A
Environment: −20°C to +55°C

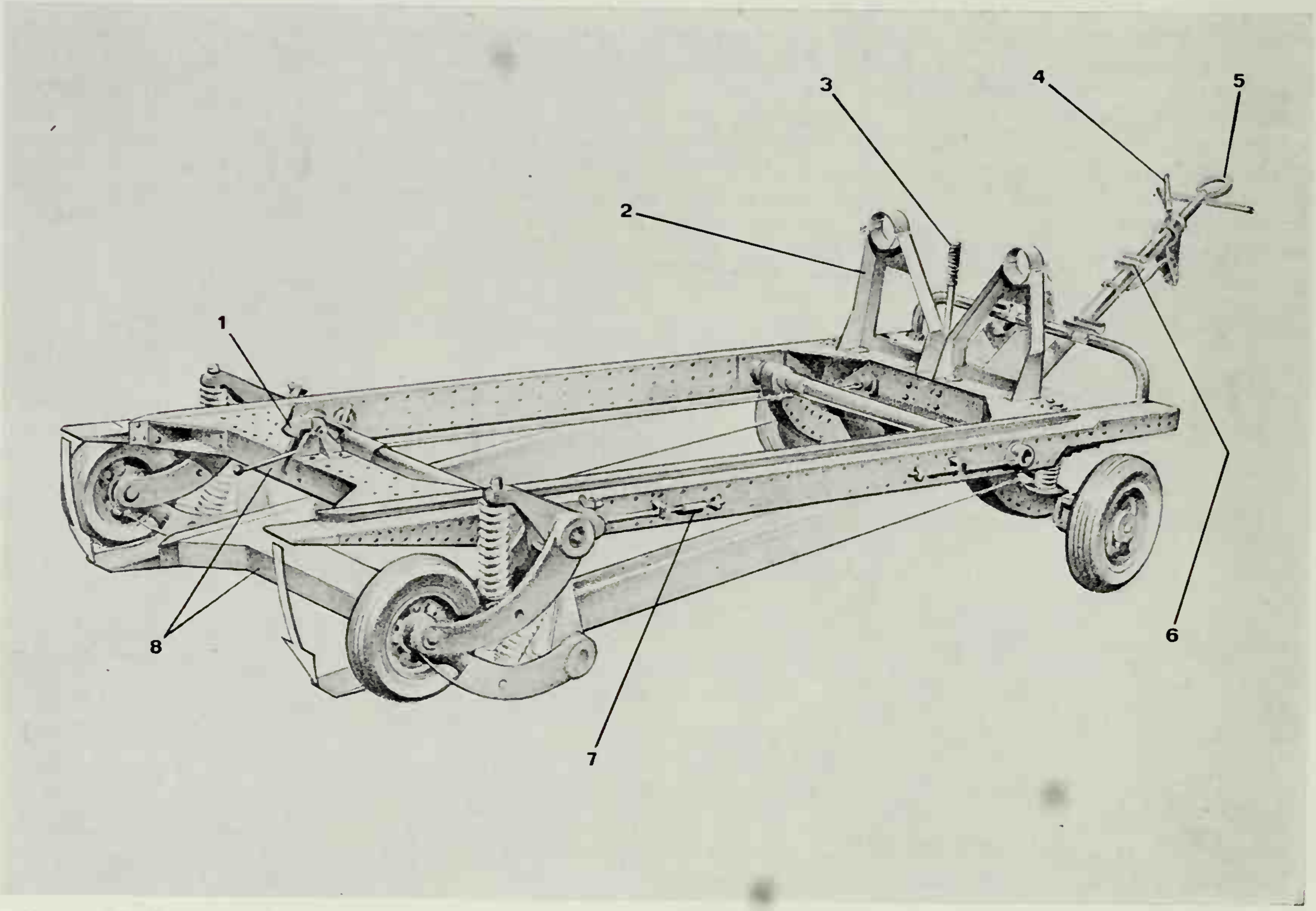
Circuits checked: store release, fuzing, firing, jettison, operational sequence
Measurements checked: voltage, current, impedance, timing intervals, sequence, standing voltage, spurious pulse width, earthing

F G MILES ENGINEERING LIMITED
Riverbank Works, Old Shoreham Road, Shoreham-by-Sea, Sussex,
BN4 5FL, England
Telephone: Shoreham-by-Sea 4511 Telex: 87466



Universal weapon loader type 'R'

1 Detachable forks
2 Removable bomb rollers
3 Self-loading jib in stowed position
4 Extensible chassis



Transport trolley type 'E'

1 Ancillary equipment locking catch
2 C-type hoist stowage brackets
3 Raising and lowering gear
4 Hand brake lever
5 Towbar and towing eye
6 Hoist winching bracket
7 Ancillary equipment restraining hooks
8 Chassis drawn in raised and lowered positions

Servicing trolleys

for weapons and equipment loading and transport

The Universal Weapon Loader Type 'R' has been designed to meet a requirement for a weapon loader capable of accommodating a wide range of airborne weapons and stores and of loading these on to aircraft.

Under maximum load conditions the loader achieves a strength factor of 4 and can be elevated through the full lift of 184 cm (72·5 in) in less than 30 seconds, descent being controlled at a similar rate.

Power for elevation is provided by a detachable pack comprising a 3 bhp diesel engine driving a swashplate hydraulic pump. This is supplemented by a handpump which is for final positioning of the load and can be used for emergency operation. The hydraulic system incorporates a fail-safe device which functions immediately in the event of any failure.

Adjustment of the pallet is provided in all planes and is effected by manually operated controls. Large-section tyres are fitted to enable the loader to be used on seeded grass surfaces. The towbar incorporates a NATO standard eye.

Weapon loader

Specification

Capacity
Max dia of store: 76·2 cm (30 in)
Max length of store: 431·8 cm (170 in)
(any length subject to suitable stabilising)
Max load of pallet: 1134 kg (2500 lb)
Max load on forks: 660 kg (1500 lb)

Performance
Lift: 184·2 cm (72·5 in)
Height to top of fork—max: 188·0 cm (74 in)
Height to top of fork—min: 3·8 cm (1·5 in)
Height to top of pallet—max: 208·3 cm (82 in)
Height to top of pallet—min: 24·1 cm (9·5 in)

General
Unladen weight (including jib): 660 kg (1500 lb)
Wheel base, short: 210·8 cm (83 in)
Wheel base, standard: 271·8 cm (107 in)
Wheel base, extended: 287·0 cm (113 in)
Overall width: 99·1 cm (39 in)
Max length (wheel base std.) exclusive of 182·9 cm (72 in) long detachable towbar: 370·8 cm (146 in)
Tyre size: 45·7 × 17·8 cm (18 × 7 in)

The Transport Trolley Type 'E' provides local site-to-site transportation for mobile test and servicing trolleys on which aircraft radar and other ancillary units are mounted. The rear end of the trolley chassis may be lowered to the ground for loading and unloading.

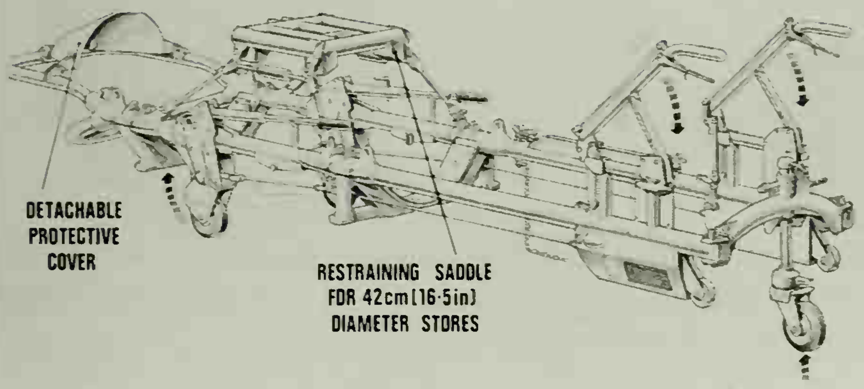
The trolley chassis of all-riveted light alloy box section construction is mounted on four independently sprung pneumatic-tyred wheels, the front two being fitted with internal expanding shoe-type brakes.

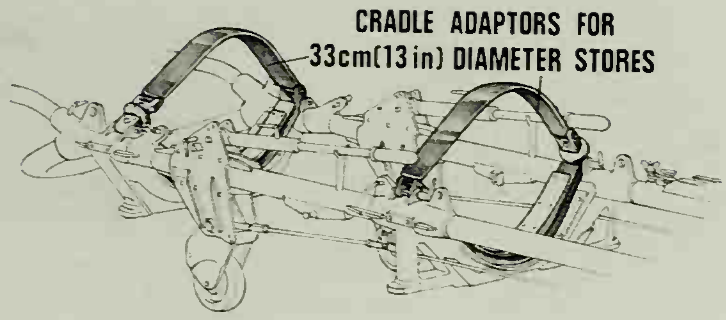
Transport trolley

Specification

Length (including draw-bar): 403 cm (13 ft 2·5 in)
Width: 122 cm (4 ft)
Height (less winch brackets): 44 cm (1 ft 5 in)
Tyre size: 76·2 × 355·6 mm (3 × 14 in)
Max turning radius: 427 cm (14 ft)
Unladen weight: 170 kg (375 lb)
Max allowable loading: 313 kg (692 lb)
Max towing speed: 8·0 km/h (5 mph)

Torpedo trolley


DETACHABLE PROTECTIVE COVER
RESTRAINING SADDLE FOR 42cm(16·5in) DIAMETER STORES



The Torpedo Trolley No. 2 is designed to provide a compact storage, transit and loading trolley for airborne weapons, suitable for use on board naval vessels.

Loaded to its capacity of 295 kg (650 lb) it has been tested to factors of 4 vertically downwards, 1·5 in the fore and aft and horizontal planes, and 6 in the slinging condition.

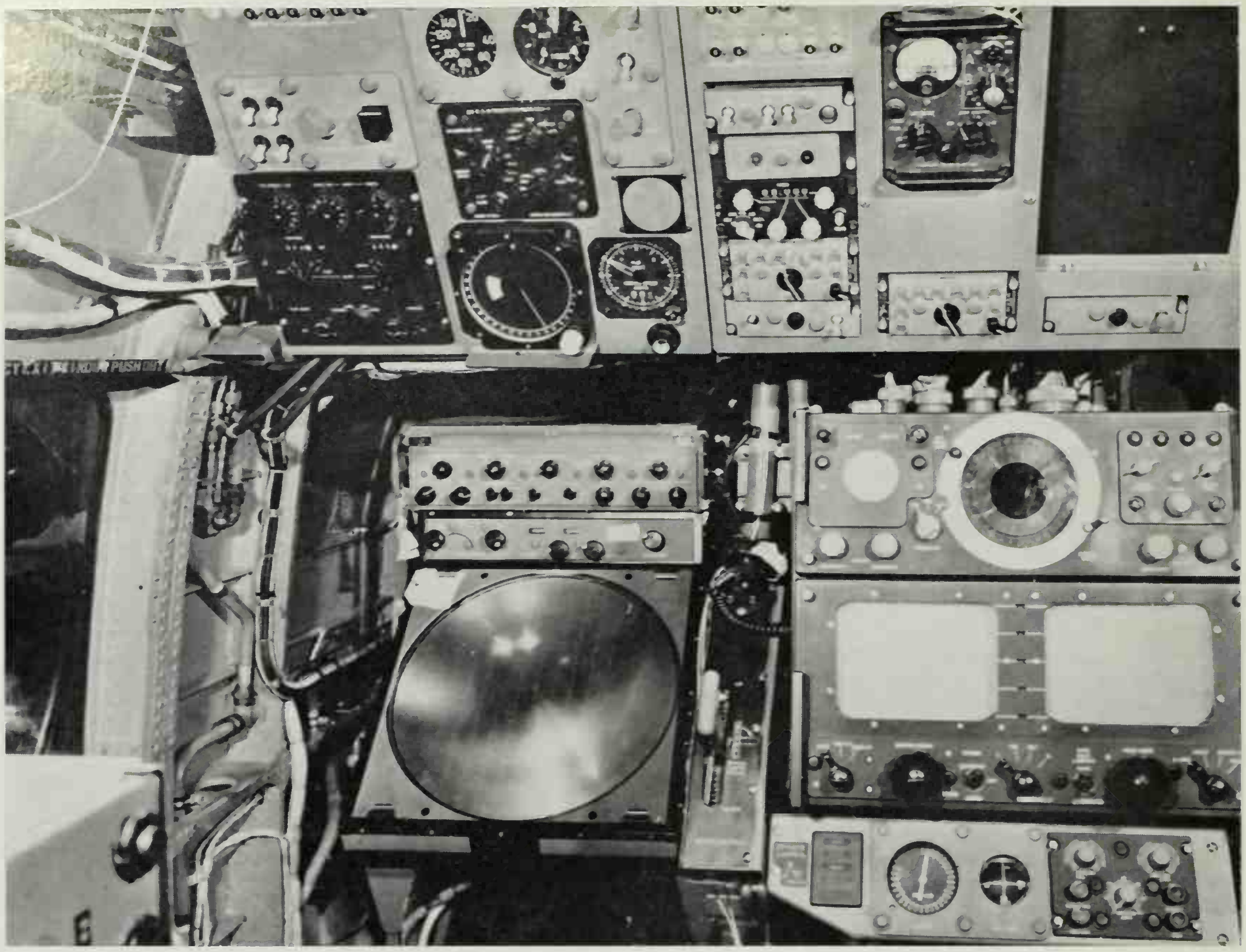
'Omniballs' on the underside of the trolley engage specially provided deck rails to which the trolley is secured by clamps, which withstand vertical shock loads of 120 g. The rear wheel is provided with a lockable castoring action; all wheels are adjustable vertically. In stowage the wheels are fully retracted clear of the deck. Individually operated fail-safe parking brakes are fitted to the two main wheels. Hoisting points are provided for winching up.

Specification

Capacity
Max dia of store: 41·9 cm (16·5 in)
Max length of store: 284·5 cm (112 in)
Max weight of store: 294·8 kg (650 lb)

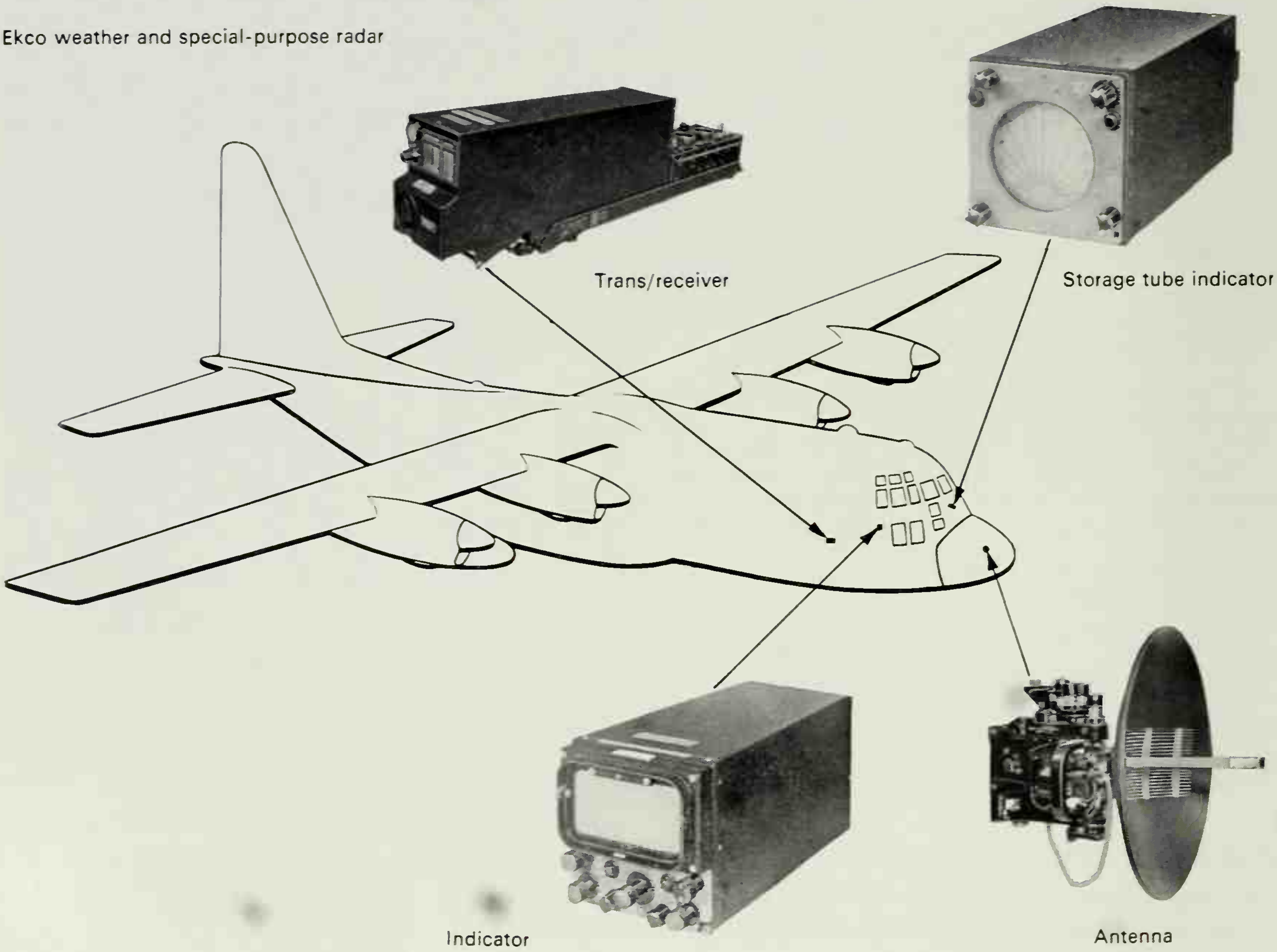
General characteristics
Unladen weight (trolley bare): 128·4 kg (283 lb)
Height above ground—max: 85·1 cm (33·5 in)
Height above ground—min (brake handles depressed and wheel retracted): 49·5 cm (19·5 in)
Overall length (rear wheel normal): 310·2 cm (122·12 in)
Overall length (rear wheel castored through 90°): 307·3 cm (121 in)
Overall width: 65·1 cm (25·63 in)
Cradle and 'Omniball' centres: 90·2 cm (35·5 in)
Turning radius: 203·0 cm (80 in) approx
Track of front wheels: 52·1 cm (20·5 in)
Track of 'Omniballs': 34·3 cm (13·50 in)

PORTSMOUTH AVIATION LIMITED
The Airport, Portsmouth, Hampshire, PO3 5PF, England
Telephone: Portsmouth 62251 Cables: Portavia Portsmouth Telex: 86205



Ekco tactical radar in Westland Sea King helicopter

Ekco weather and special-purpose radar


Trans/receiver
Storage tube indicator
Indicator
Antenna

Airborne radar

Tactical, weather and special-purpose systems

Ekco tactical radar for helicopters and fixed-wing aircraft

Developed by Ekco in association with the British Ministry of Technology, the Ekco tactical radar system is now in service with the British Navy and has been ordered by a number of other naval forces. It meets the requirement for all-weather aircraft operations in the following roles: anti-submarine, air/sea rescue, mines counter-measures.

The aircraft equipped with the complete Ekco system forms the control centre for the whole operation, the radar display being the focal point for all information and acting as an operational plotting board.

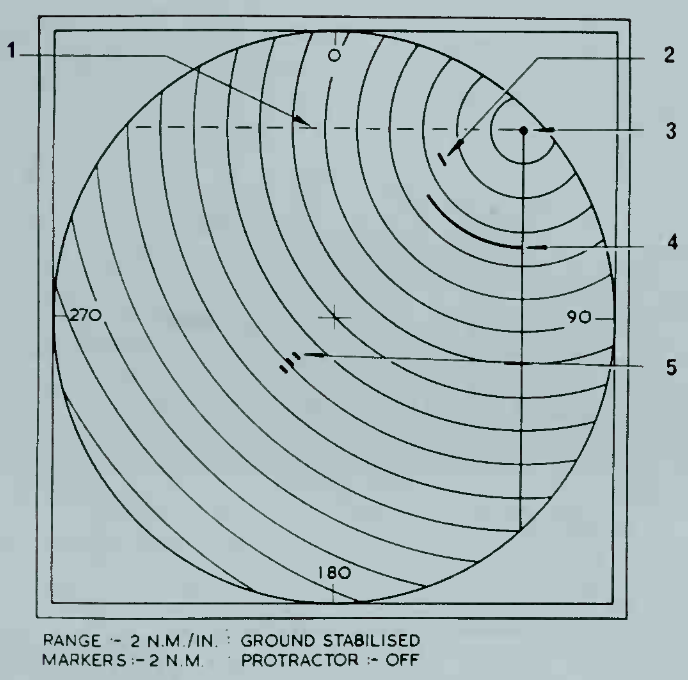
Information displayed includes a) primary radar echoes from other aircraft, vessels and terrain, b) echoes from aircraft, helicopters or surface vessels equipped with the associated transponder units, c) range and bearing of sonar contacts.

The range of the system is up to 50 nautical miles (93 km).

The secondary radar facility provides positive information and permits low-altitude helicopters to be plotted at much increased ranges in the presence of sea clutter.

Primary and secondary radar can be displayed separately or together.

The operator has the choice of three modes of presentation: conventional plan-position indication, ground-stabilised, and ground-stabilised with offset.


1
2
3
4
5
0
270
90
180
RANGE :- 2 N.M./IN. : GROUND STABILISED
MARKERS :- 2 N.M. : PROTRACTOR :- OFF

The above diagram illustrates a typical helicopter radar display presentation:

1. Aircraft heading marker (270°)
2. Ship or helicopter not fitted with transponder
3. A/C position
4. Sonar contact (transfer data or position marker) (180°)
5. Transponder reply (225°)

Ekco weather and special-purpose radar

Ekco weather and special-purpose radar systems are designed to provide not only excellent long-range weather and terrain mapping facilities, but also a special short-range high-resolution display giving a capability in airborne approach, search and rescue, as well as in other roles.

Special features of the equipment include:

Special short-range high-resolution display in addition to weather radar characteristics.

Wide- and narrow-pulse trans/receivers for optimum long- and short-range operation.

Search and rescue capability with optimised performance in calm and rough sea conditions.

Duplication of electronic units with cross-switching facility for in-flight reliability.

Direct-view CRT display with 18 kV operating voltage and special screen phosphor giving exceptional brightness and excellent resolution, together with simplicity of operation.

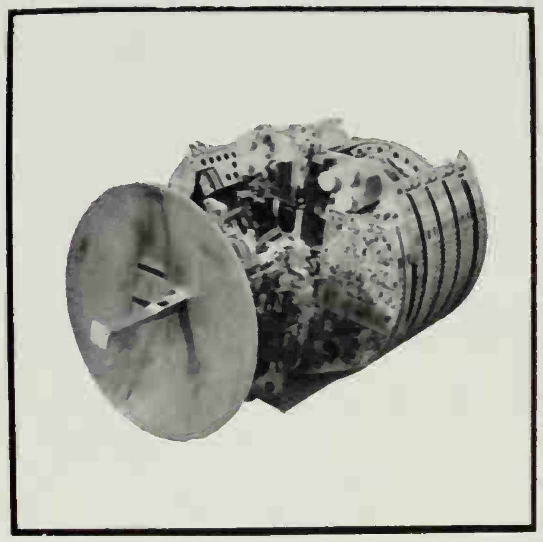
Trans/receivers employ solid-state modulator and head IF amplifier.

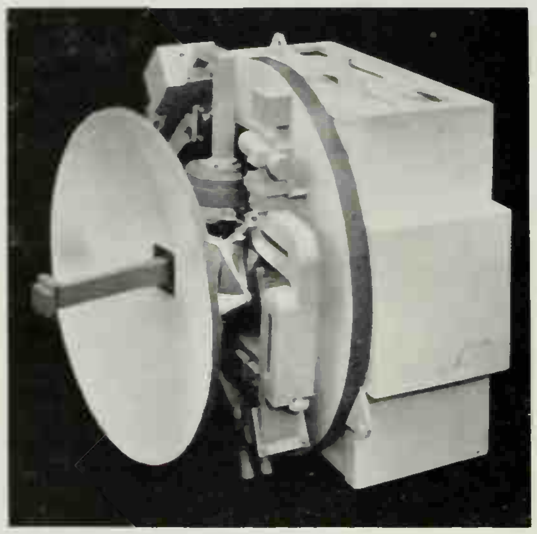
Variants for helicopter installation are available.

Other types of equipment by Pye and Ekco are described elsewhere in this Catalogue

EKCO AVIONICS
A Division of Pye Telecommunications Ltd
Southend-on-Sea, Essex, SS2 6PW, England
Telephone: Southend-on-Sea 49491 Cables: Ekco Southend Telex: 99167

The Ferranti Airpass radar prior to mounting





Right: The Ferranti lightweight ranging and terrain-following radar

Left: The Ferranti terrain-following radar

The Ferranti target-illuminating radar, a mobile ground-based unit

Radar systems

for aircraft and mobile ground use

Ferranti Ltd has 20 years of experience in the design, development and production of airborne and ground radars, and introduced the first high-power monopulse airborne equipment to go into squadron service anywhere in the world. Ferranti now makes a wide range of radar units for a variety of military and civil uses. The most important military radar units are briefly described below.

Airpass radar

The Ferranti Airpass is a radar system available in three different forms, each adapted to meet different requirements.

Airpass I
This is an air-to-air interception and fire control system. It is employed on the BAC Lightning aircraft.

Airpass II
This is a dual-purpose system, for both air-to-air and air-to-ground fire control and bomb aiming, developed for dual-purpose interception/strike aircraft. Provision is also made for ground mapping, terrain clearance and avoidance, and for other modes of operation. The equipment is exceptionally compact and light in weight.

Airpass III
This is a versatile air-to-surface system employed in the Hawker Siddeley Buccaneer aircraft. It is capable of ground mapping, radar ranging, terrain warning and conventional weapon aiming.

Forward-looking radar

Developed from the Airpass series of airborne equipments, this multi-mode radar provides ground mapping, beacon homing and radar ranging modes of operation in addition to a full terrain-following capability at clearance heights of 65m (200ft) or above in straight or turning flight. More than 200 hours of test flying under representative conditions have proved the solidity and integrity of the equipment.

Lightweight ranging and terrain-warning radar

The Ferranti lightweight ranging and terrain-warning radar is a multi-mode system of exceptionally compact design, modular in conception and based on the use of solid-state devices. Although it offers both radar ranging and terrain homing modes of operation, the entire equipment weighs only 11kg (25lb).

Target-illuminating radar

The Ferranti target-illuminating radar is a mobile ground-based system operating in the X-band. It is used with BAC Thunderbird and Bloodhound missiles. It searches for, acquires and tracks the target, while at the same time illuminating it.

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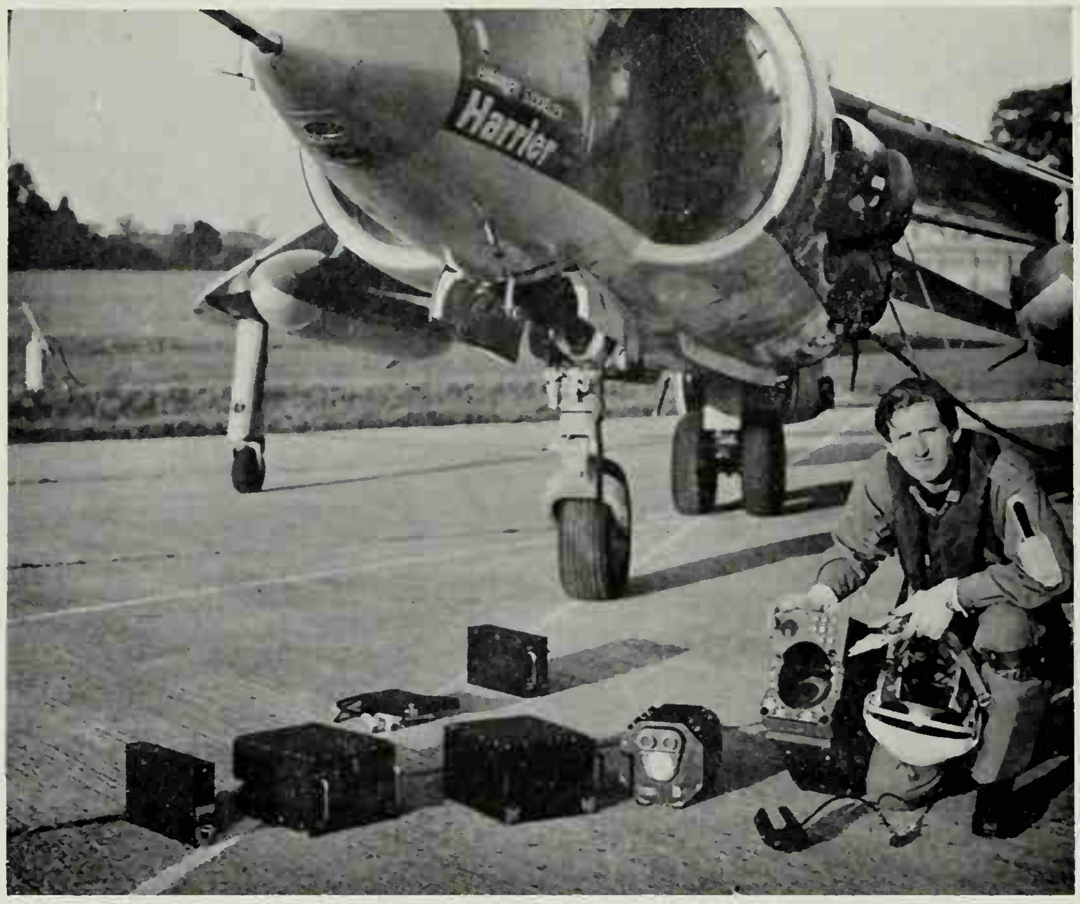
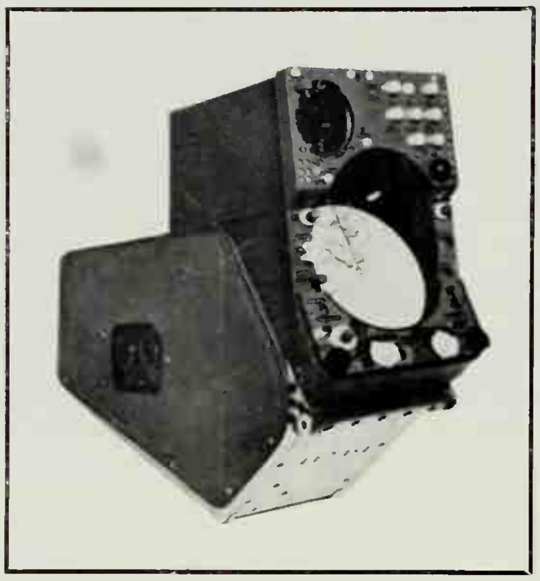
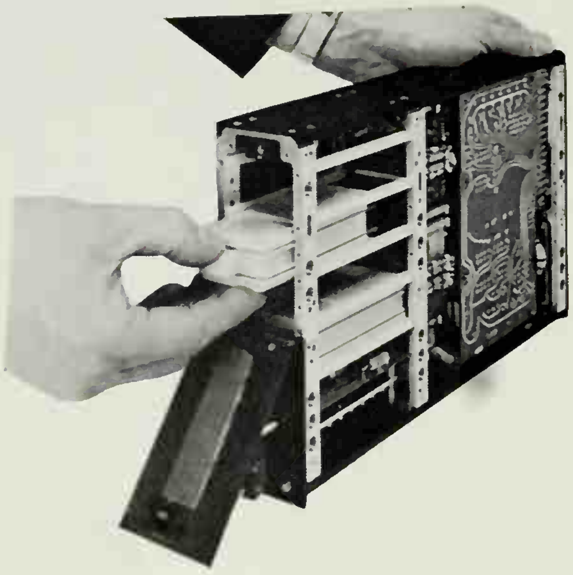


The Ferranti Inertial Navigational/Attack System (INAS) as used on Harrier aircraft. The entire system, which includes the necessary power supplies, is housed in several compact self-contained units, thus permitting installation in aircraft of widely differing types



Above: The display unit, with all controls for the INAS system conveniently grouped together

Below: The INAS ballistics box, showing the extensive use of printed circuit boards and plug-in modules



INAS inertial systems

for aircraft navigation and attack

The Ferranti INAS (Inertial Navigation/Attack Systems) in the Harrier and Phantom aircraft are self-contained systems of proven accuracy, independent of external aid, free from detection and interference. The Harrier system is configured for a single-seat aircraft, the Phantom system for two-man operation. The essential computations and several of the units are identical in both systems.

Inertial measurement

The basic measurements for navigation and weapon aiming are made by an inertial measuring system which incorporates the well-established Ferranti miniature inertial platform. When the system is switched on a built-in test, lasting for a few seconds, is applied to all the units. It is then switched into an automatic self-alignment sequence. When this is complete the system is switched into navigation after which present position, groundspeed and track for navigation, velocity vector and attitude for weapon aiming are continuously supplied.

The Harrier system

The Harrier system comprises the inertial platform, present-position computer, navigator control, navigation display and computer, weapon-aiming computer, ballistics box, hand controller and power supply.

The most exacting demand on the system is the achievement of low-level strike at first pass. All the facilities and performance provided for navigation, target finding and weapon aiming are dictated by this requirement.

Operational facilities

Navigation

Range and bearing indicator: The navigation display and computer stores target, base and other destination co-ordinates, compares these with inertially derived present position and computes range and steering signals to the selected destination. These are displayed on the range and bearing indicator. The pilot can navigate to target and return to base via any combination of stored destinations.

Moving map: A topographical moving map display is provided which allows the pilot, by relating it to the outside environment, to check on system accuracy and, if necessary, to correct it. The map is projected from 35 mm film in a choice of scales. On the map face present position is displayed within the circle at the centre and on counters optically superimposed. A third counter provides a read-out of a variety of navigation information which can be monitored by the pilot. A radial line indicates track.

The continuously updated display of information on range and bearing indicator and moving map enables the pilot to assess the navigation situation in a minimum of time head-down. The steering signal is repeated on the head-up display. He can therefore concentrate on head-up tactical low-level navigation, with minimal exposure and without risk of disorientation.

Target finding

As the pilot approaches the target, its computed position is indicated to him by an inertially stabilised target bar on the head-up display. After a precise local update procedure this bar defines target position with an accuracy which gives a high probability of finding even small targets from low level at first pass.

Weapon aiming

Automatic release: As soon as the target is found the pilot can employ the target bar to effect automatic release. Using the hand controller, he places the bar over the target and by doing so brings the computed target into co-incidence with the real target, to an accuracy consistent with the aiming of conventional weapons. In this automatic release mode the aircraft is relatively free in elevation.

Manual release: Alternatively the pilot has the option of manual release, in which the provision of inertial velocity and attitude enable him to engage strike with freedom in his initial height, range and speed.

Targets found at first pass can therefore be engaged at first pass.

Either automatic or manual release may follow a planned approach.

Unplanned attack: It is possible to attack targets immediately, with automatic or manual release, even though their position is not previously known. This is termed unplanned attack.

Air-to-air the system provides for lead-pursuit attack.

Weapons: Ballistic information relating to the weapon selected is supplied from an appropriate ballistic plug insertable in the ballistics box. Any variety of weapons can be handled by interchanging these plugs; for a new or modified weapon the only requirement by the system is for a new plug.

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Weapons sighting systems

for air-to-air and air-to-ground attack

Since 1943 Ferranti has manufactured over 45 000 gyro gunsighting systems, and this experience has led to the development of Ferranti ISIS (Integrated Strike and Interceptor Systems). This is a range of compact optical sighting systems which covers the operational requirements of most ground-attack aircraft.

The philosophy of ISIS is to have a choice of sighting heads to meet the space requirements of various cockpits, but using virtually the same weapon aiming computation required for air-to-air interception and air-to-ground attacks with guns, rockets or bombs.

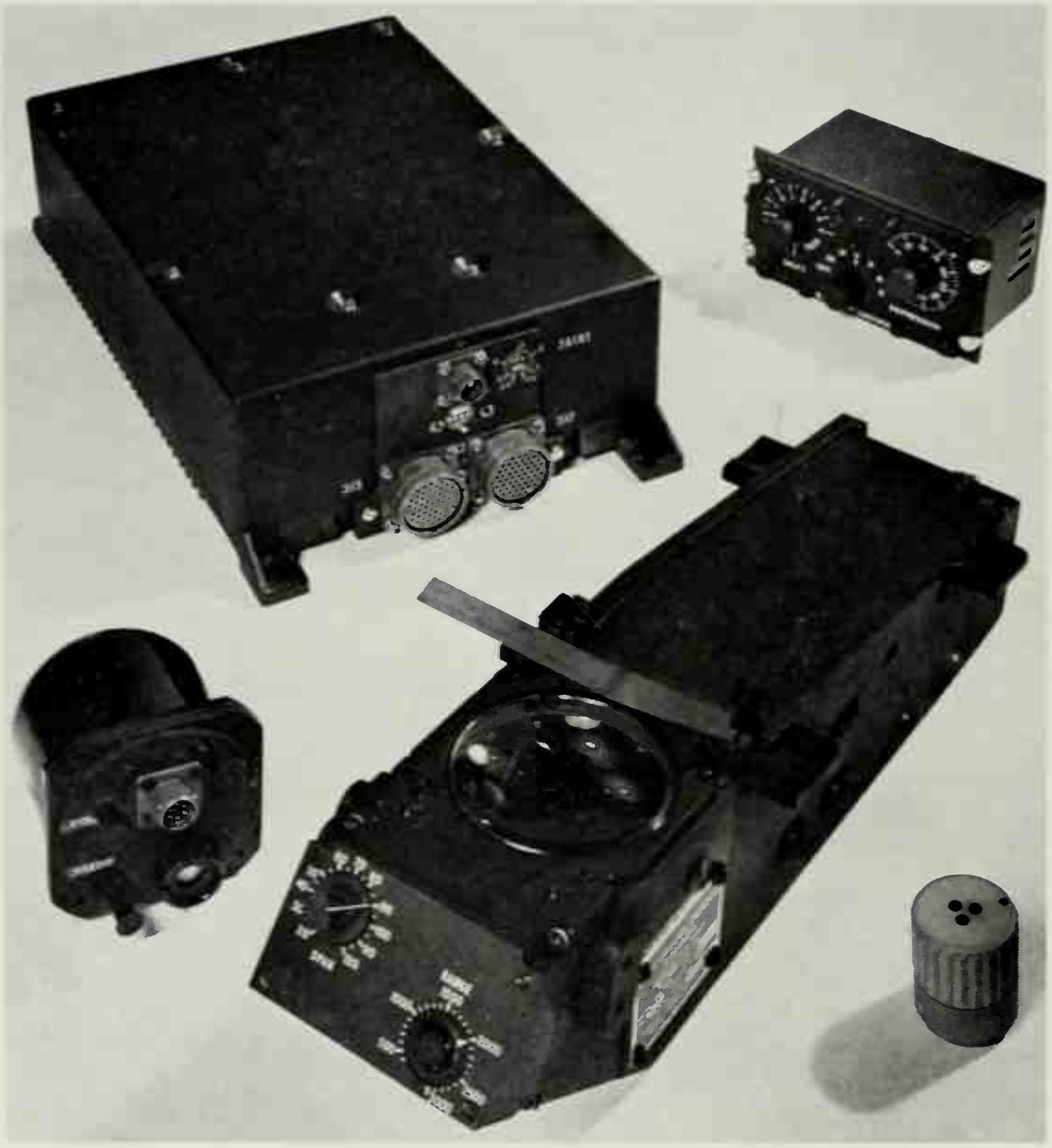
LFS/5: This is the simplest member of the present family, consisting of a sighting head only. It provides one gyro-controlled aiming pattern with fixed sensitivity, fixed speed and fixed dive angle and has been supplied to a number of overseas Air Forces in the Macchi MB326 and BAC167 aircraft.

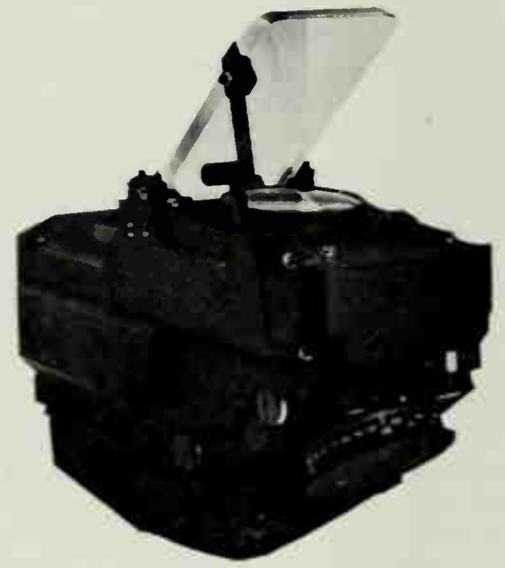
ISIS F-2: This system is similar in concept to ISIS F but has a separate control unit whereby the pilot may 'dial' his sight-line depression and cross-wind component just prior to the attack. ISIS F-2 is designed with the building block technique in mind. The ISIS N-type computer and ISIS B bomb release units may be added to form the ISIS B-N system. This system is designed to fit the MDC Skyhawk, the Hindustan HF 24 and the SAAB 105

ISIS D: This sighting head may be used as a head-up display unit, either for weapon aiming or as a means of displaying steering signals. It is basically an ISIS F sighting head, with the additional stand-by provision of a fixed (non-gyro) aiming symbol which can be manually deflected both upwards and downwards

ISIS B: This system, as fitted to the Fiat G.91-Y aircraft, comprises a sighting head, a computer unit, a switching unit and an automatic bomb release unit. It employs fixed sensitivity in the air-to-air mode, so there is no ranging unit. The aiming pattern is roll-stabilised and, in the air-to-surface modes, there is continuous speed compensation from a Doppler input, with two fixed dive-angle settings. The system can also accept a Doppler drift input. A proposed development will replace the fixed dive-angle settings by continuous compensation from an external pitch input

ISIS N: This system has been purchased by the Canadian Defence Forces for the Northrop CF-5 aircraft. It is also being considered by many other air forces. It consists of a sighting head, a computer, a pilot's control unit and a ranging unit. Stadiametric ranging is provided and altitude compensation comes from the air data computer in the aircraft. In the air-to-surface modes there is continuous speed compensation from the air data computer and continuous dive-angle compensation from the aircraft reference gyro-pitch output. The aiming pattern is roll-stabilised. Provision is made for either manual or Doppler drift allowance and a manually operated depressed sight-line mode is provided. An automatic bomb release unit can be incorporated, the system then being designated ISIS NB.

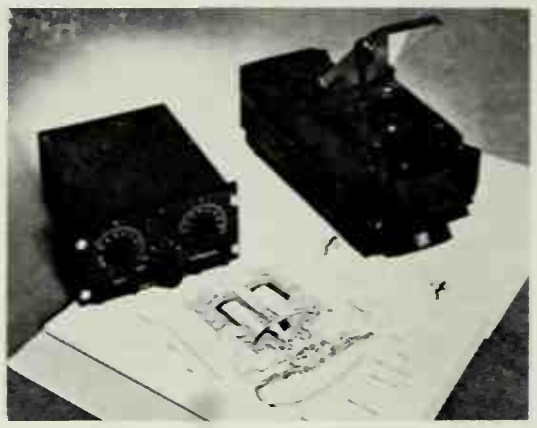




Above: Ferranti ISIS D sighting head

Left: component parts of the ISIS N sighting system

Below: component parts of the ISIS F sighting system



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Laser ranger

and marked target seeker

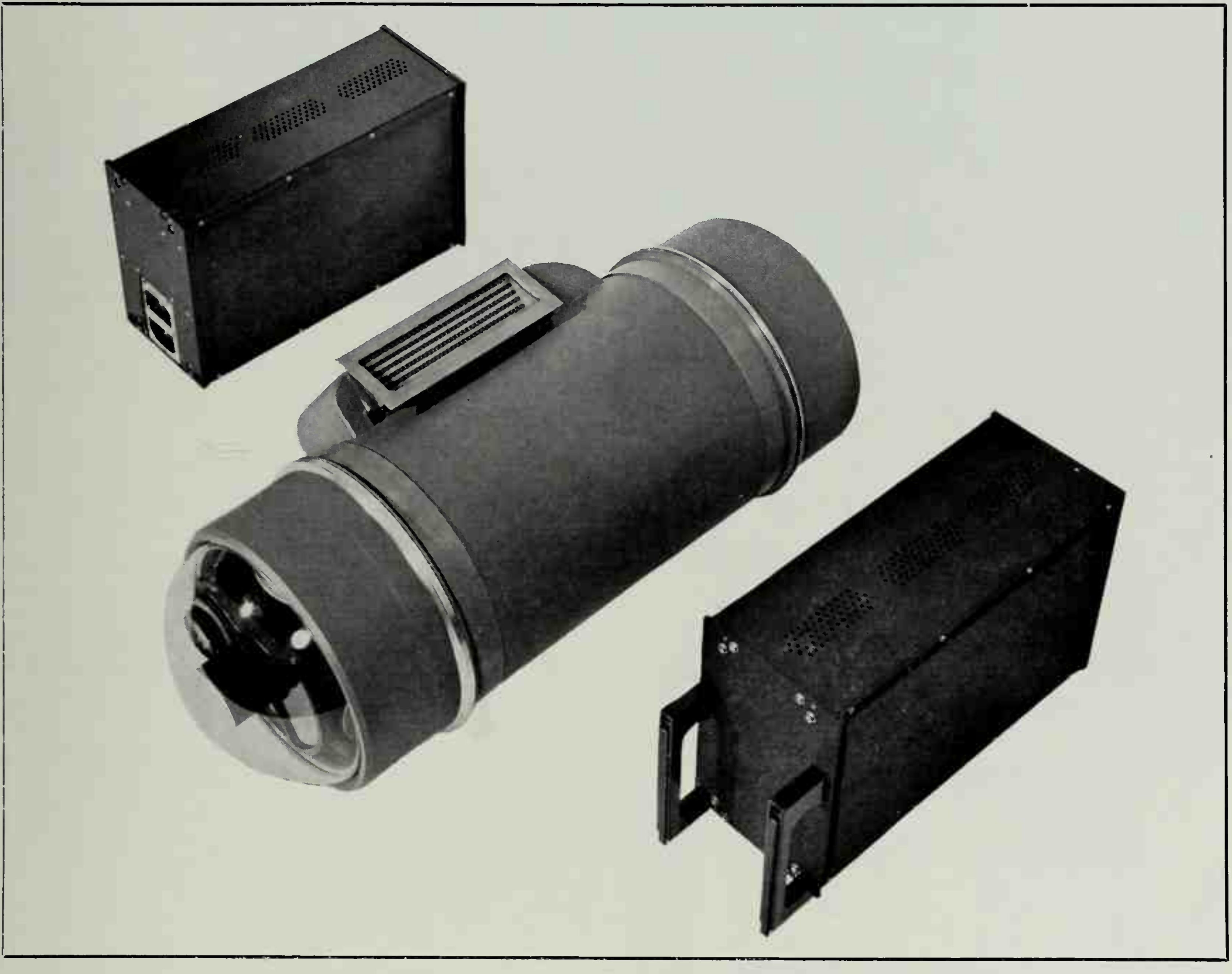
Ferranti's expertise in weapon aiming equipments provides the foundation for the Laser ranger and marked target seeker. The system provides an aircrew and airborne weapon-aiming systems with complete data on range and direction to a target during ground attack; it also has an air-to-air ranging mode.

Range to the target is one of the most important data requirements in an airborne weapon system. The Laser ranger combines the narrow beamwidth and short pulse features of a laser with gyro stabilisation to provide an equipment which is more accurate and has a faster response than any other means of deriving range. The equipment may be used solely as a rangefinder. However, a marked target seeker has been incorporated with little extra complexity to the basic ranger. This combined highly compact system, used in conjunction with a laser target marker aimed by a forward air controller, automatically provides the pilot and weapon system with complete range and direction to a target.

The Laser ranger operates by directing a pulse of infra-red energy at the target. Range is then derived by measuring the time interval between transmitting the pulse and receiving the scattered energy.

The marked target seeker operates by acquiring and tracking scattered energy from a target illuminated by a ground marker. The head-up display is then driven to indicate the target position to the pilot. In this equipment range is also measured when the seeker tracks the target.

The equipment normally comprises three units: the stabilised laser unit, the power unit and the ancillary electronics unit.



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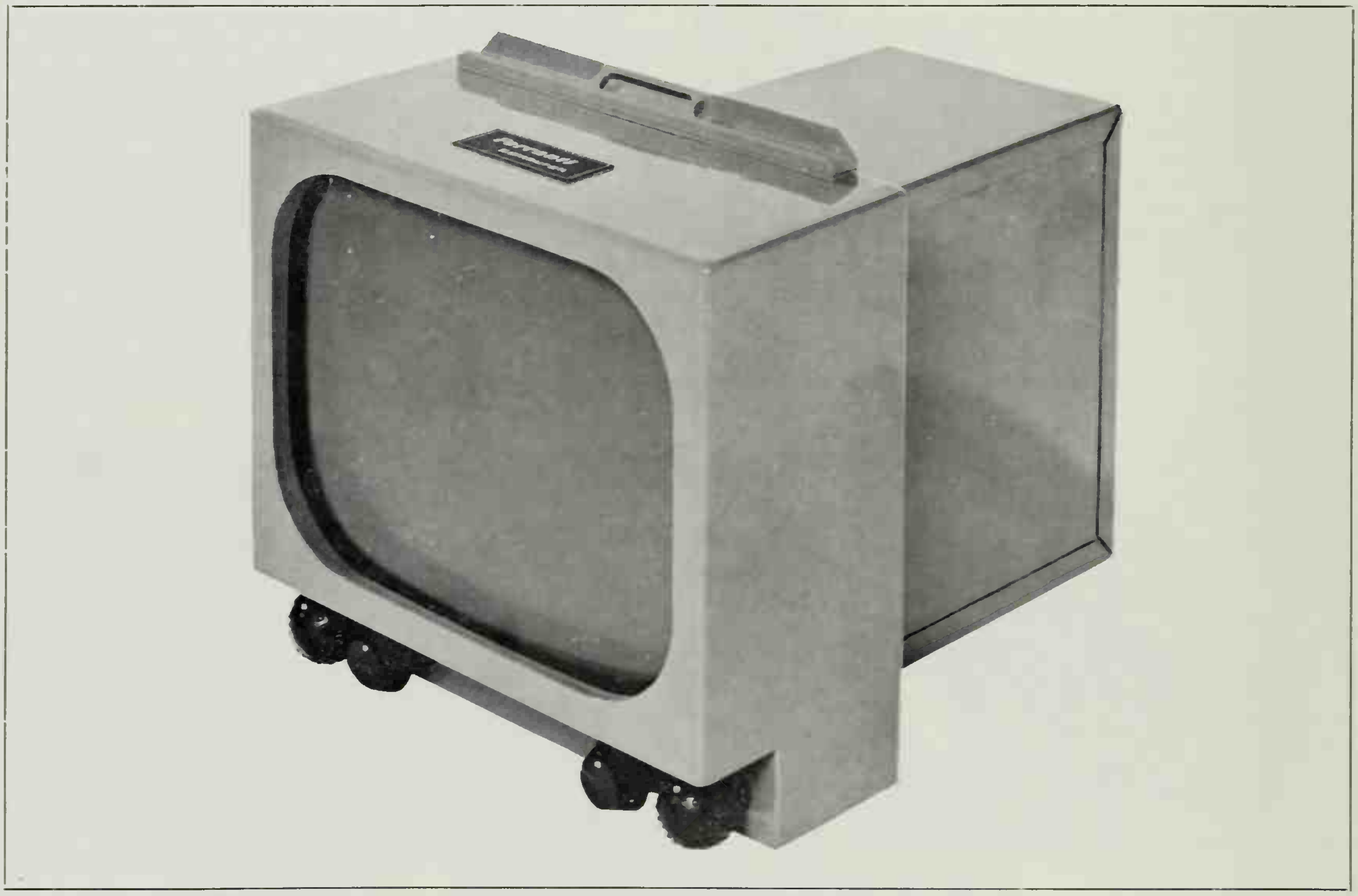
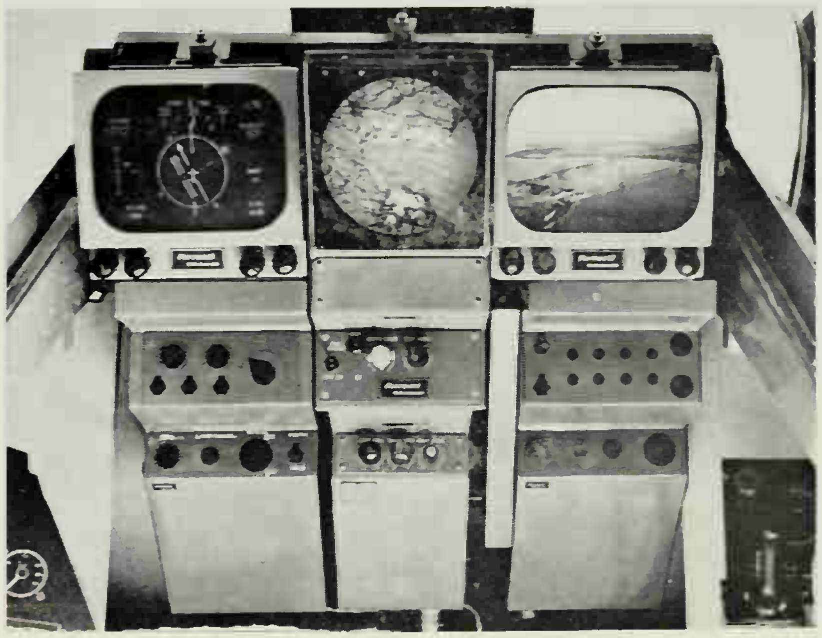
Head-down display

Unihedd universal head-down display

This compact, versatile display is suitable for a wide range of applications in all types of civil and military aircraft, hovercraft, ships and submarines, armoured vehicles, mobile and static ground stations. Information may be displayed from a large variety of sources and sensors including tabular, symbolic, TV, navigation, radar, sonar, counter measures and computer graphics. The modular construction allows the updating of individual portions of the display as improvements in the state of the art occur.





Unihedd

Unihedd can present much of the electronic information required by the crew of modern transport or military vehicles and is shown here as part of an integrated assembly for an aircraft. Alphanumerics, symbology, radar map matching and television are presented here.

FERRANTI LIMITED
Electronic Systems Department
Ferry Road, Edinburgh, EH5 2XS, Scotland
Telephone: 031-332 2411 Telex: 72141

FERRANTI

Weapon control system

for aircraft armament

Advanced electronic and digital techniques have been employed in the design of Plessey systems for the planned engagement of various armaments and stores carried by aircraft, resulting in a reduction of costs and a very great increase in system reliability.

Systems fitted currently to strike aircraft depend for their distribution methods on a variety of rotary switches located at various positions in the cockpit, making it extremely difficult for the pilot to release stores in sequence and thus to preserve aerodynamic balance. The Plessey system concentrates all armament selectors and controls on one panel, minimises the possibility of selection errors by discriminating between valid and faulty selections (the latter are ignored), and automatically ensures that the balance of the aircraft is not upset. By concentrating the controls on to one panel, the work load on the pilot is reduced to a minimum. A system similar to that described here is fitted currently to the Harrier VTOL fighter aircraft.

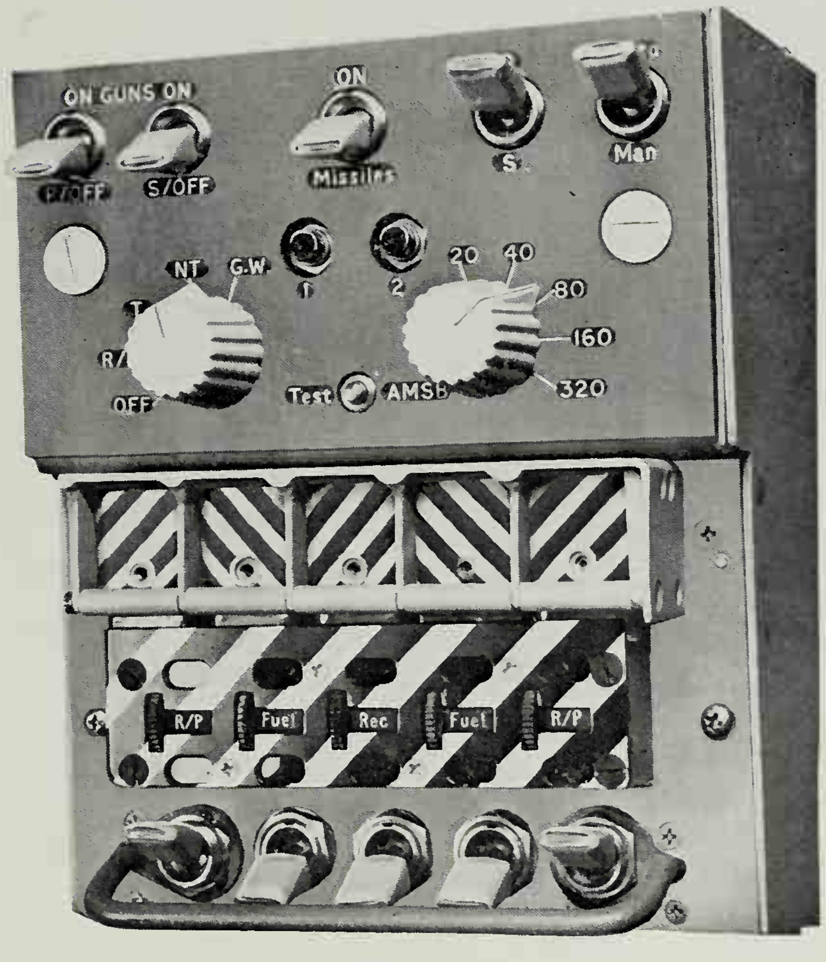
The equipment is divided into two main parts: the main unit (which can be fitted in the nosewheel bay), and the control unit fitted in the cockpit. The main unit, in addition to containing most of the electrical circuitry, carries five rotary switches which are set up by the armourer when he loads stores on to the pylons. The control unit carries all the pilot-operated switches. The 'Clear Aircraft Switch', which is used to jettison the entire payload in salvo or single jettison, can be on the control unit or mounted separately so that it is placed suitably for emergency operation. A great improvement in reliability has been achieved by removing from the neighbourhood of the pylons all but the essential minimum of circuit components, connectors, bomb-off microswitches and the ejector release units, and ensuring that even if these were damaged the integrity of the system as a whole would remain intact. All power supplies to the weapon control panel and all release lines from it are duplicated for reliability.

Power supply

The weapon control panel operates from a power supply whose voltage varies from 24 to 29 V; the jettison system can operate down to 18 V. Supplies are drawn from both A and B busbars and are fed directly to the jettison system; they are also fed through fuses to the normal release system.

Temperature and climatic conditions

The weapon control panel will function satisfactorily up to 90°C in exceptional circumstances and in all climates normally over the temperature range from –40°C to +50°C at altitudes up to 15 000 m (50 000 ft).



Armament distributor control unit

THE PLESSEY COMPANY LIMITED
Electronics Group
Vicarage Lane, Ilford, Essex, England
Telephone: 01-478 3040 Telex: 23166

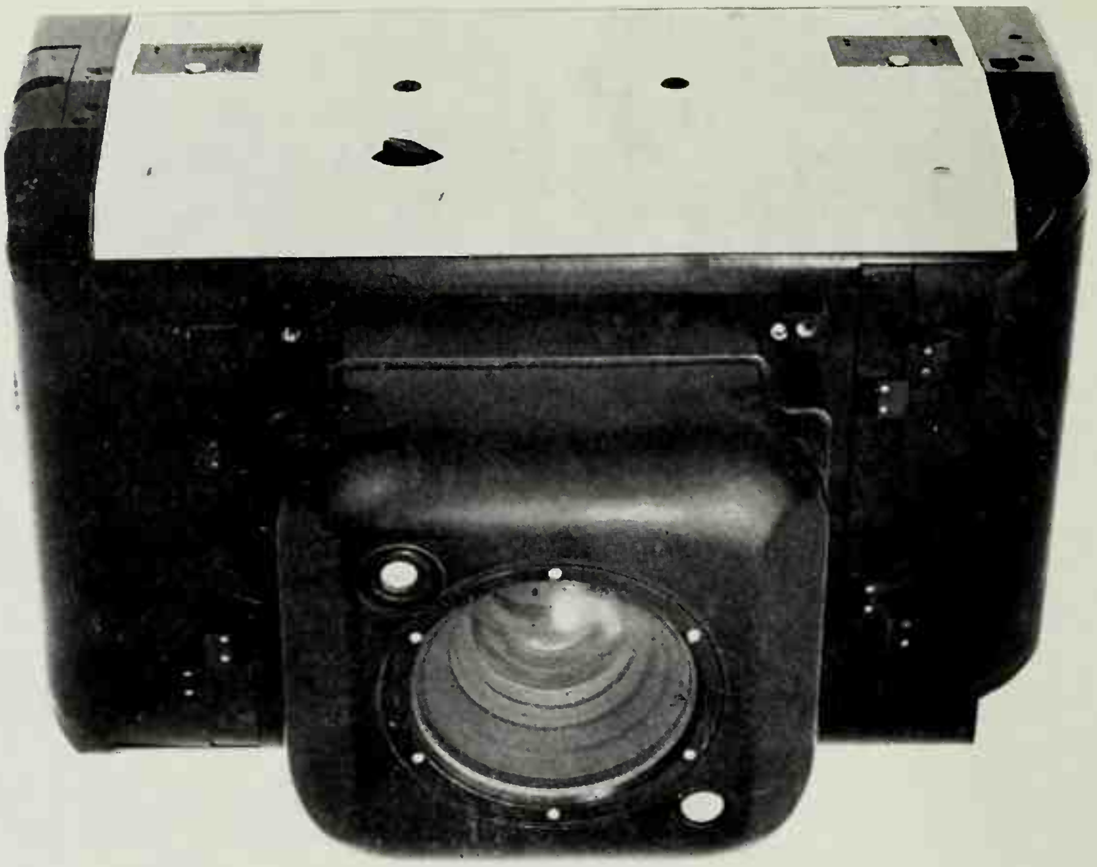
1969

Section 19

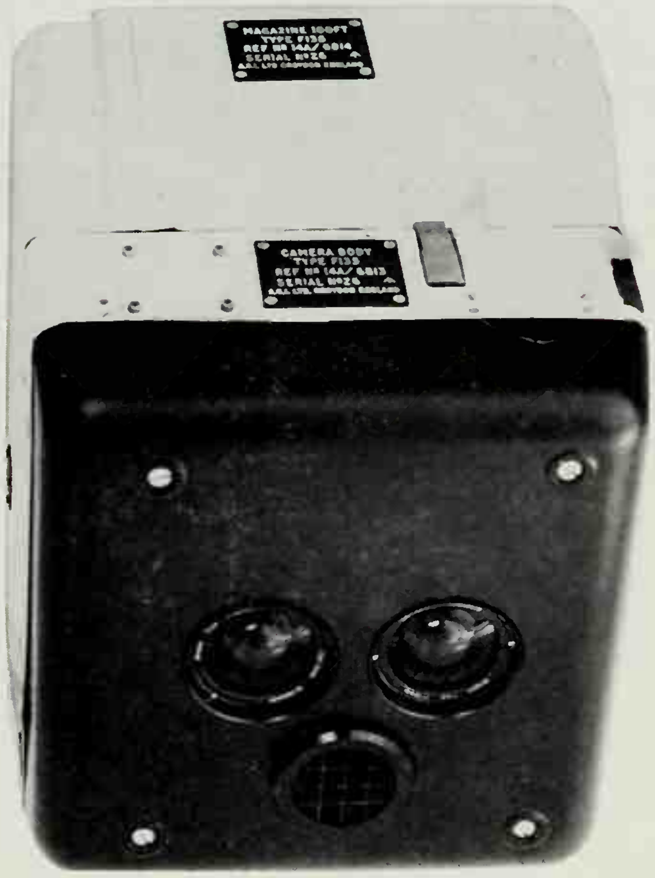
Aerial reconnaissance equipment

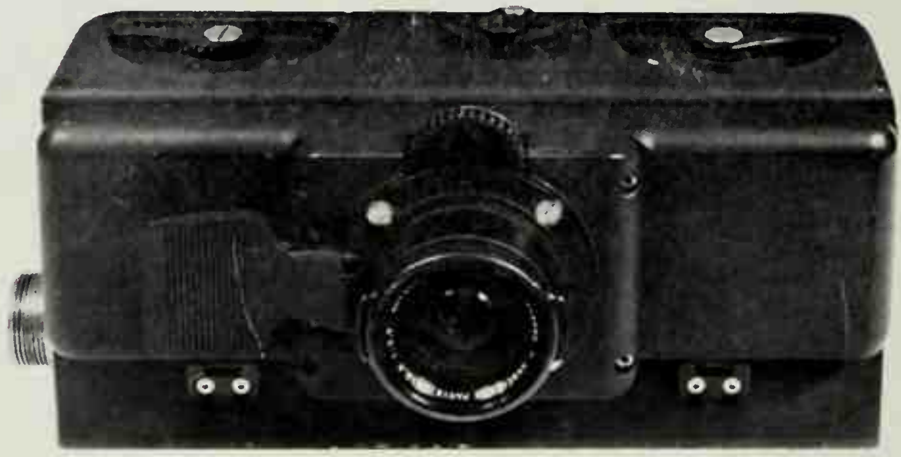
The three cameras described here are in series production for the Royal Air Force. The F.126 and F.135 are used on Nimrod, Phantom and Harrier aircraft. The R.128 is fitted to Nimrod.

All three cameras are the result of extended development work and have been thoroughly tested in use under all conditions in all parts of the world.

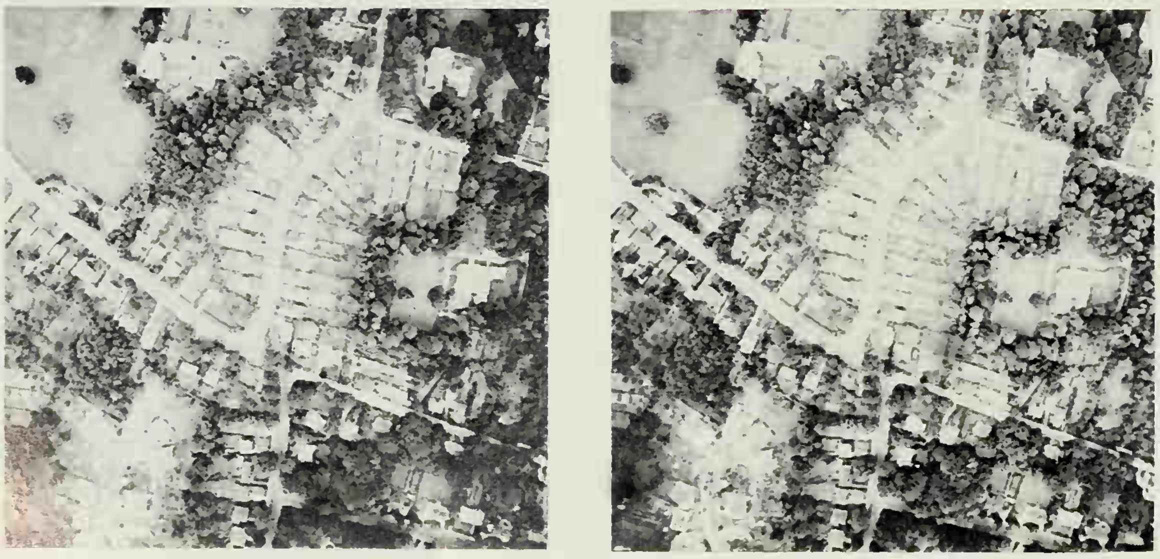


The F.126 large-format camera with four interchangeable lenses, IMC, built-in heaters and optional flight data recording input facility





Above: mounted on a hood, the R.128 photographs the sweep of a CRT display on 35 mm film. Through a separate control box manual or automatic continuous recordings can be made



Left: a typical pair of stereo photographs taken with the F.135 shown above these photographs. Designed for high-speed low-level operations, photography down to 30 m (100 ft) is possible by virtue of high shutter speeds and IMC. It can be used at night with electronic flash

Reconnaissance cameras

High-speed stereo, large-format and radar recording

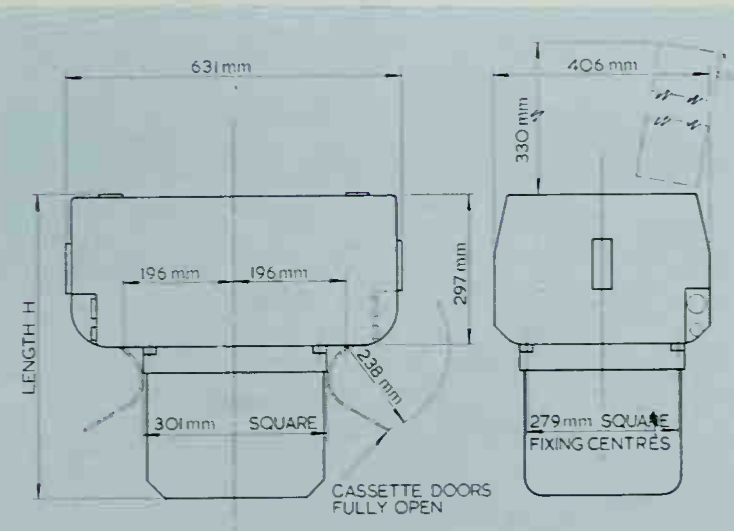
F. 126

The F.126 is a daylight large-format reconnaissance camera with interchangeable lenses from 150 to 900 mm focal length.

The film is clamped during exposure by an assembly moving at IMC (image-movement compensation) speed. Each picture is numbered on exposure. A closed-loop high-accuracy auto-iris system ensures correct exposure of films within the NATO groups 2 to 7. The lenses of longer focal length are automatically focused for altitude.

Optional flight data recording, synchronised from the camera shutter, is also available. Thermostatically controlled heaters are built in for use in low ambient temperatures.

Lens: interchangeable 150 mm f5·6, 74°; 300 mm f4·5, 41°
600 mm f5·6, 20°; 900 mm f6·3, 15° (angle of view is edge to edge)
Shutter: focal plane, 1–2 or 4 milliseconds
Iris: automatic, closed loop, four-cell averaging; accuracy ±1/3f stop
Data: picture numbering, optional 64-dot data panel, shutter-synchronised
IMC: automatic from velocity and height data or manual; range 0·005 to 0·3 radians per second
Ground overlap: 60%
Format: 228 × 228 mm
Exposures: 320 per load
Film load: 75 m of 240-mm film, NATO groups 2 to 7
Radio suppression: to British Standard 2G-100, Parts 2 and 3
Power: camera alone: 28 V dc 5 A (15 A peak)
Heaters: camera 4 × 25 W; lens cone 8 × 25 W—thermostatically controlled
Supply: 115 V, 400 Hz



LENS FOCAL LENGTH	LENGTH H	WEIGHT *
914 mm	798 mm	66·2 kg
609 mm	798 mm	65·3 kg
305 mm	472 mm	55·3 kg
152 mm	318 mm	49·9 kg

* WITH CASSETTES BUT WITHOUT FILM

F. 135

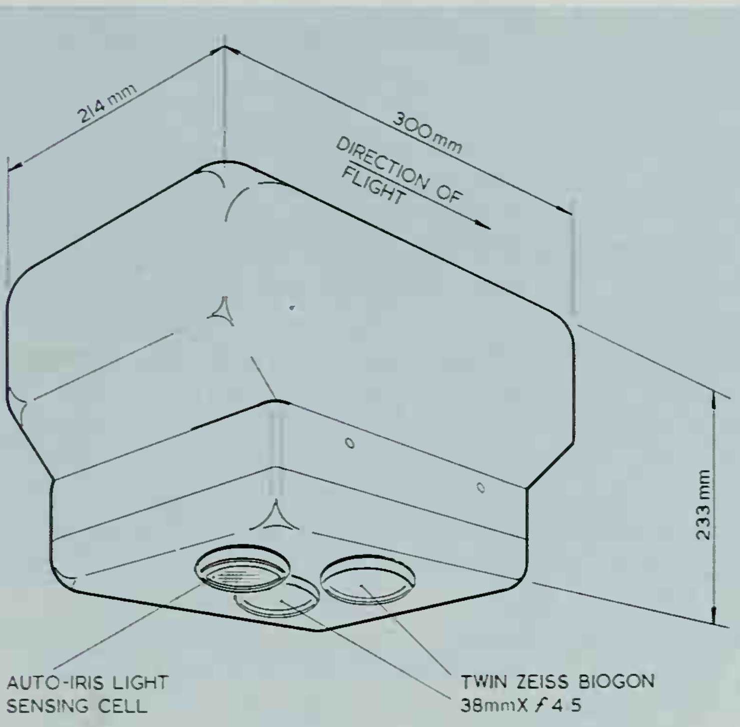
The F.135 is a day/twilight/night stereo reconnaissance camera. It is intended for high-speed very low-altitude duties between 30 m and 300 m, for example Mach 1 at 50 m.

This role calls for a high picture repetition rate, a fast shutter speed, a very responsive automatic control of exposure level and very accurate high-speed image movement compensation.

When allied with colour in stereo the intelligence gathering capability of the F.135 camera is unquestioned.

Any F.135 camera can be used as a master camera to synchronise several slave cameras. The light cell system automatically controls iris and shutter speed. Thermostatically controlled heaters are built in for use in low ambient temperatures.

Lens: 38 mm f4·5 wide-angle 74° edge to edge
Shutter: electrically operated between-lens type
day: automatic control 1–4 milliseconds
night: constant 4 msec, with a triggering pulse for initiating the flash during the shutter-open period
Iris: automatic, open loop, accuracy ±1/3f stop
Data: 64 dot binary code system, shutter-synchronised
IMC: automatic from velocity and height data or manual; range 0·1 to 5 rad/sec
Ground overlap: 50/50 mode 50%; ripple mode 10%
Format: 57 × 57 mm in pairs
Exposures: 500 × 2 per load
Film load: 40 m of 126-mm film, NATO groups 2 to 7
Radio suppression: to British Standard 2G-100, Parts 2 and 3
Power: camera alone: 28 V dc 5 A (15 A peak)
Heaters: camera 50 W; magazine 50 W—28 V dc or 115 V 400 Hz
Weight: 12·25 kg without film

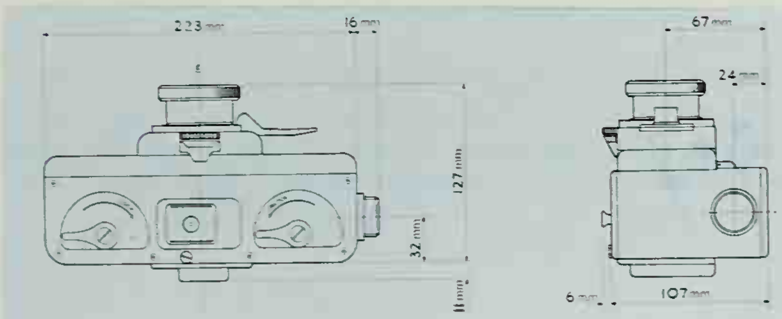


R. 128

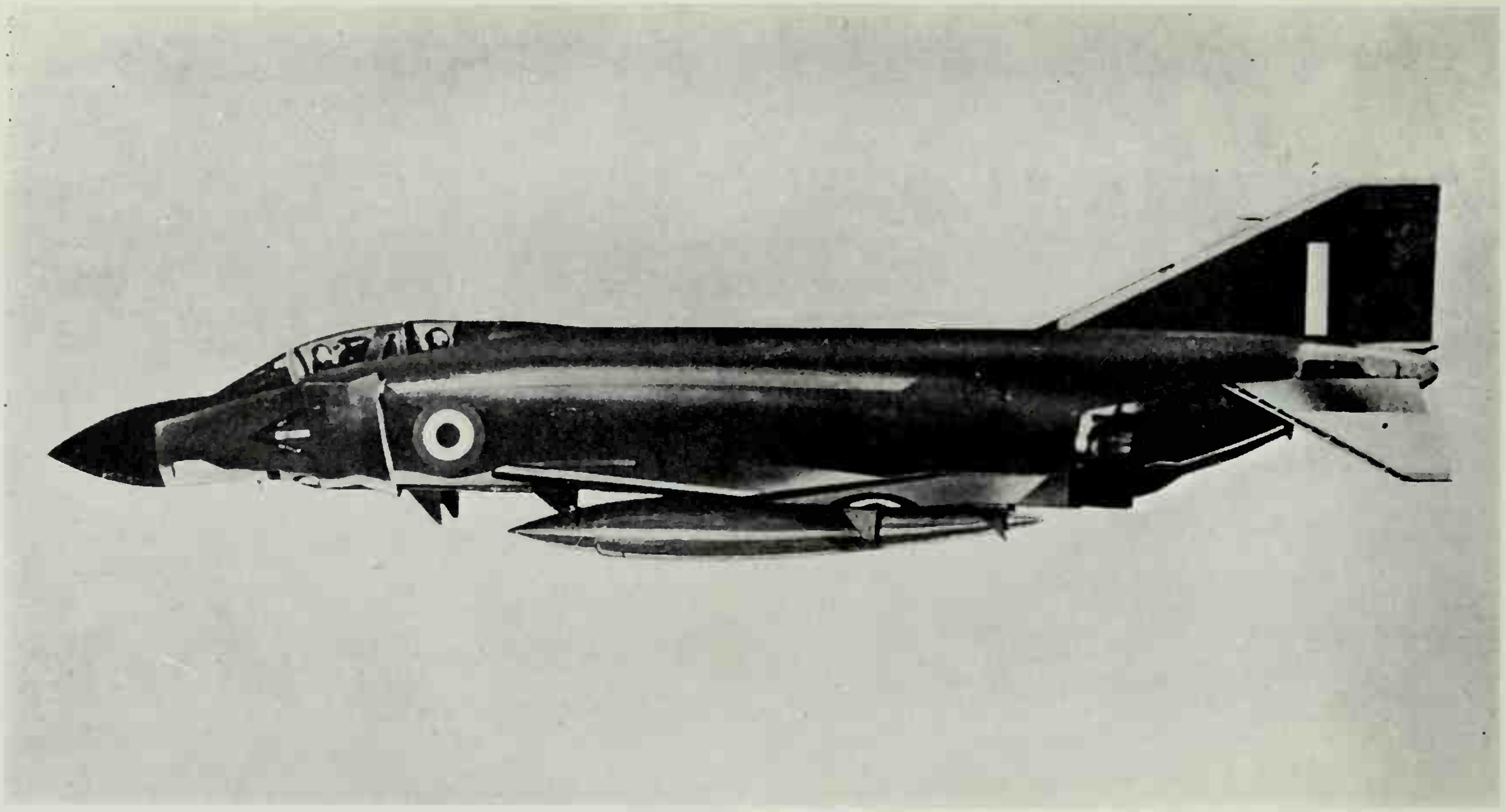
The R.128 recording camera is mounted on a hood over the radar screen and is used to record full or sector scans from a manual control or automatically. A full standard 35 mm film loading gives 500 frames.

The camera is fitted with an Angenieux lens of 18·5 mm focal length × f2·2 aperture adjustable. Its weight, complete with film, is 2·5 kg.

The camera is daylight-loaded by cassette. Frame number and time are automatically recorded on each exposure, plus information on an insertable reusable 'write-on' data panel.



AERONAUTICAL & GENERAL INSTRUMENTS LTD
40 Purley Way, Croydon, CR9 3BH, England
Telephone: 01-684 3211 Cables: Instradio Croydon Telex: 262960



Phantom aircraft with EMI reconnaissance pod attached

Specification

Radar

A Q-band high-resolution radar is employed. The aerials are slotted wave guides and are contained in the walls of the pod. The transmitter / receiver is mounted near the fore end of the pod and the mapping recorder, which is by far the largest unit in the system, near the after end.

The latter contains two cathode ray tubes for recording the radar returns, while between them is a data matrix for recording data from the navigational equipment in the aircraft. The displays from these form a straight line, by means of an optical system, and a film is drawn across the displays at a rate proportional to the speed of the aircraft. The marks shown on all three displays are thus transferred to the film.

Two range scales are provided. On the lower scale the radar map is displayed on one CRT and shows the ground on either side of the aircraft, but only echoes of targets moving with respect to the ground (MTI) are shown on the other tube. On the upper scale, MTI is not shown and one CRT shows the radar map to port of the aircraft while the other shows the starboard side map.

It follows that when on the lower scale the film will show the radar map and the MTI picture with a series of dots between them which represent the inserted navigational information in binary code. On the upper scale the film shows only the radar map and the navigational information.

Infra-red line scan

This equipment comprises a receiver and a mapping recorder.

Cameras

Three different fits are provided for the following purposes:

Fit 1 for low-altitude day and night use,

Fit 2 for high-altitude use, and

Fit 3 for oblique use.

Cameras used are manufactured by Aeronautical and General Instruments Ltd, and W. Vinten Ltd

Data converter

The purpose of this equipment is to supply navigational data to the recording sensors (radar, line scan and cameras).

Data are obtained in analogue form from the Ferranti inertial navigation system and from the STC altimeter. The data are digitised and fed to the records made by the sensors on receipt of a suitable signal demand pulse. The annotation on to the recording media is made in binary code by solid-state light sources. These are gallium phosphide diode lamps arranged to form a 64-bit matrix.

The data converter also computes the parameter V/H for image motion compensation within the recording sensors, using ground speed and radio altitude data.

Another function of the data converter is to compute elapsed distance by integrating ground speed with respect to time and thus to generate the signal demand pulse mentioned above. This is so arranged that the navigational information is placed on the records at set distance intervals. Thus on the radar record the navigational data appear every one nautical mile, while on the line scan record they appear every $\frac{1}{2}$ and 4 miles.

The unit is kept small by the use of advanced electronic concepts such as integrated circuits, multi-layer printed circuit boards and sub-miniature wire-wrapped connectors.

A high degree of reliability is obtained.

Reconnaissance pod

for aircraft mounting

As far as British military aircraft are concerned, it is general practice to fit aerial reconnaissance equipment either in a separate external pod which is mounted below the aircraft, or to fit it into a pack or pallet which can be mounted instead of bombs in the bomb bay or inside the aircraft itself. Whichever method is employed, the aim is to achieve simplicity in mounting so that the entire reconnaissance system can be attached or detached from the host aircraft in less than an hour.

Typical pod

A typical reconnaissance pod, such as that shown diagrammatically below, was designed for the F4M Phantom aircraft. The aircraft with the pod mounted below it is shown in the illustration on the opposite page. This pod contains the following equipment:

(a) Sideways-looking radar

(b) Passive infra-red line scan equipment and a recorder,

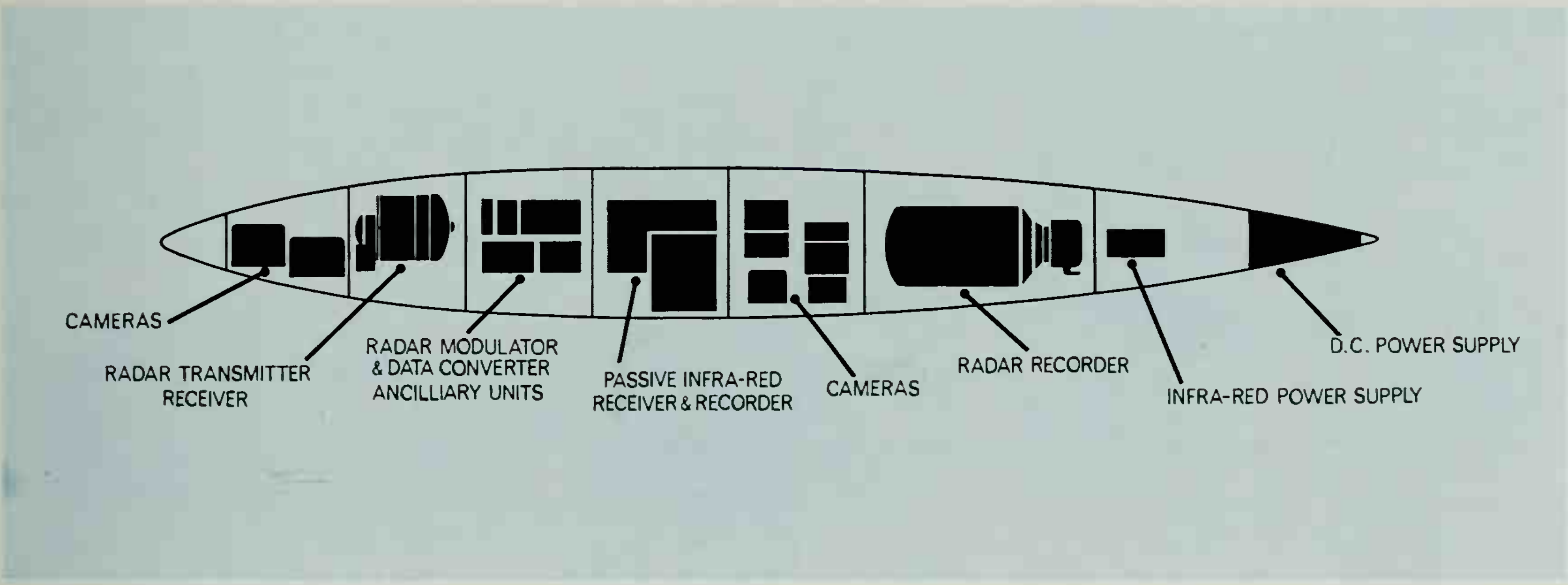
(c) Day and night cameras (up to eight cameras can be fitted, as required)

(d) A radar recorder on which radar returns are recorded, and

(e) A data converter for converting navigational data from the aircraft's navigational instruments and to feed them to the radar recorder, line scan recorder and cameras.

All the equipment listed is available mounted within the pod, as a complete reconnaissance system. The individual items of equipment can, however, also be supplied separately. For instance, studies have been carried out on the engineering work required to fit the radar equipment into pods of other sizes.

At present, a separate special pod to house the infra-red line-scan equipment only is also under development.

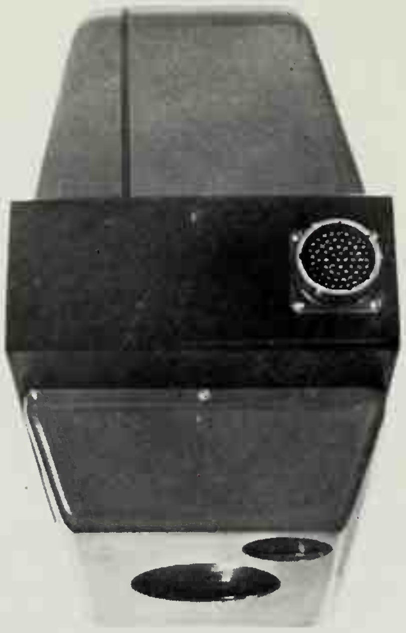

CAMERAS
RADAR TRANSMITTER RECEIVER
RADAR MODULATOR & DATA CONVERTER ANCILLIARY UNITS
PASSIVE INFRA-RED RECEIVER & RECORDER
CAMERAS
RADAR RECORDER
INFRA-RED POWER SUPPLY
D.C. POWER SUPPLY

Diagrammatic layout of equipment in the EMI reconnaissance pod, which is a self-contained unit ready for mounting on aircraft

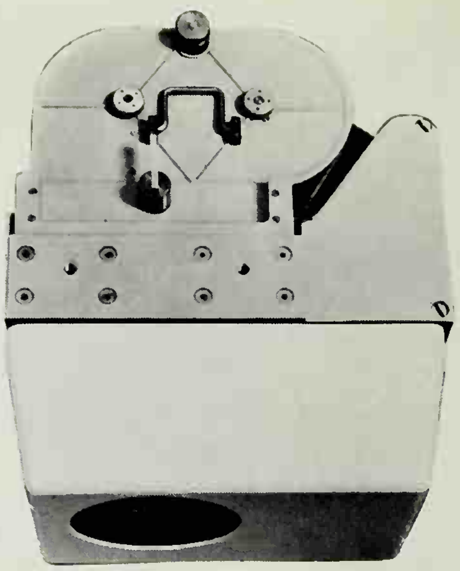
EMI ELECTRONICS LIMITED
Military Division
Hayes, Middlesex, England
Telephone: 01-573 3888 Cables: Emidata London Telex: 22417

EMI

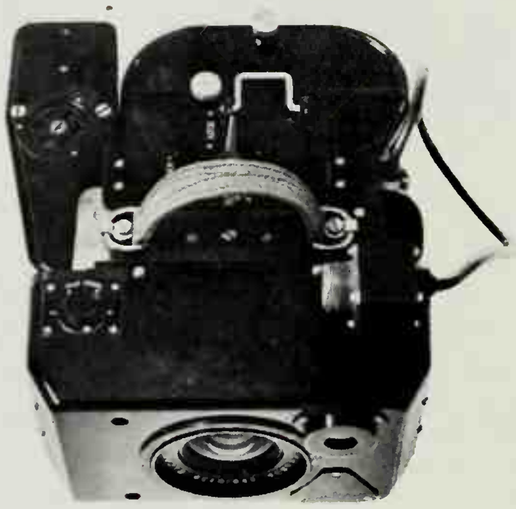
1968



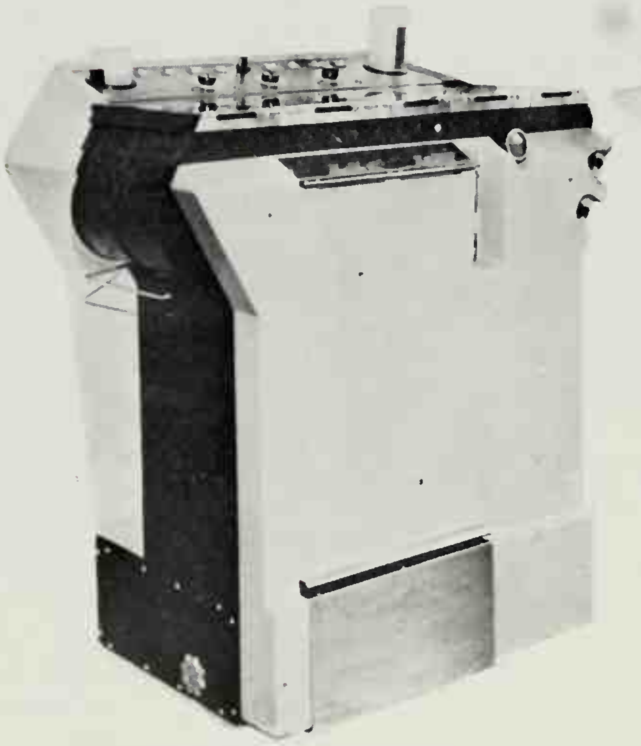
Type 590 camera



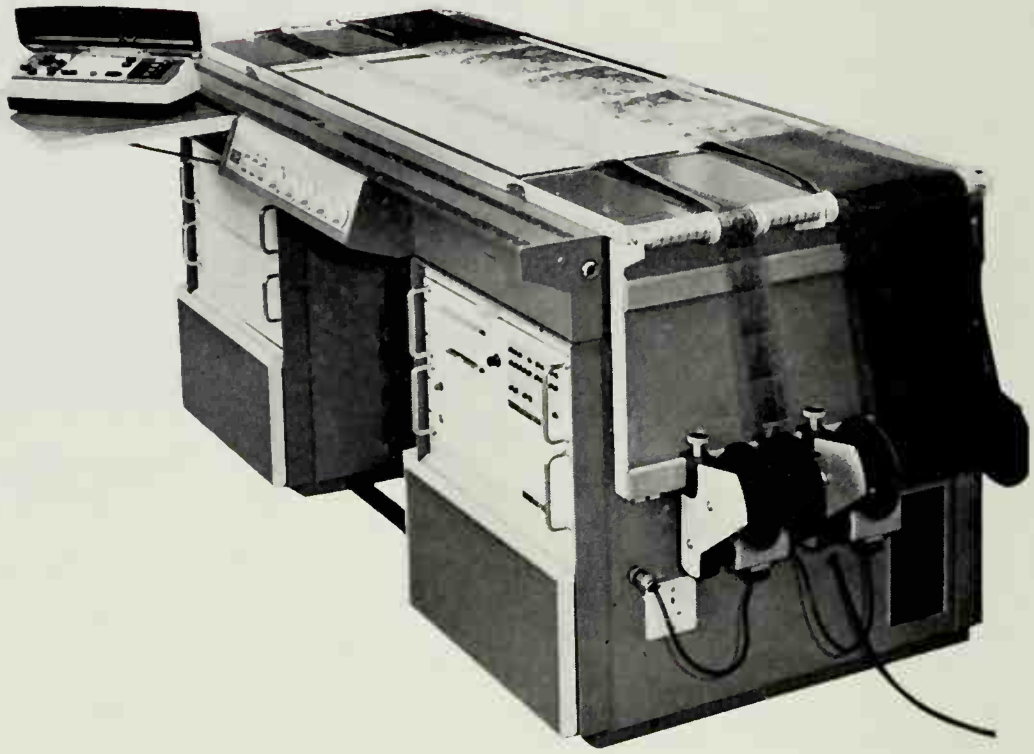
Type 591 camera



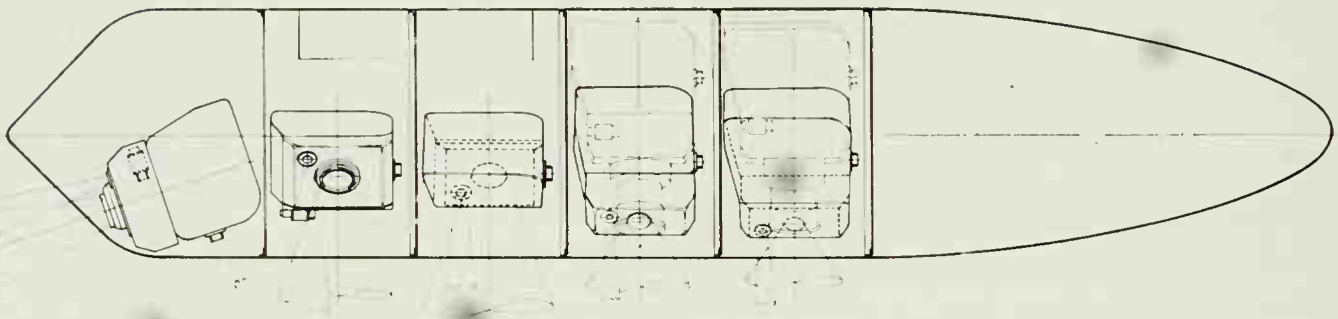
Type 360 camera with 536 automatic exposure control



Type 650 film processor



Type 652 interpretation table



Universal reconnaissance pod

Reconnaissance equipment

for aerial photography and ground support

Type 590 camera

This camera is the most advanced of its kind obtainable today. Exposure is fully automatically controlled. The 15 frames/second speed and image motion compensation facility are extremely accurate and are computer-controlled. The 590 has the ability to change from day to night operation so that reconnaissance can continue uninterruptedly. The magazine contains film adequate for 900 exposures.

Specification
Framing rate: 15 frames/sec
Frame size: 57 mm × 57 mm
Exposure time: 1/4000 and 1/5000 sec at 15 frames/sec
Film size: 70 mm double-perforated to British Standard 2696:1936
Magazine: 60 m capacity
Shutter: day focal plane, endless blind; night compur type, capping shutter
Heater: 100 W, thermostat control
Power: 28 V dc to 115 V ac 400 Hz

Type 360 camera with 536 AEC

The Type 360 camera is designed for low-level high-speed reconnaissance and is currently in use by air forces throughout the world with complete success. The Type 536 AEC (automatic exposure control) may be used on all standard Vinten cameras and offers accurate, automatic high-speed compensation of lens apertures. The 536 AEC may be fitted with lenses up to 305 mm (12 in) focal length.

Specification
Framing rate: 4 and 8 frames/sec
Exposure time: 1/1000 and 1/2000 at 4 and 8 frames/sec
Magazine: Displacement type, 30 metres capacity
Film size: 70 mm double perforation to British Standard 2696:1936
Image size: 55·5 mm and 57 mm
Heater: 100 W thermostat control (ON at 0°C, OFF at 20°C)
Power 25 to 29 V dc. Motor 3·5 to 4·4 A
Environment: To British Standard 2G 100

Type 591 camera

The Type 591 is primarily a general-purpose day/night camera suitable for high-speed low-altitude low-light reconnaissance sorties, using cartridge or electronic flash as the night illuminant. The versatility of the camera is extended by incorporating image motion compensation and an inter-lens shutter for use when the ambient light level is poor. The Type 591 is also normally fitted with an automatic exposure control lens cone.

Specification
Framing rate: 10 frames/sec
Frame size: 55·5 mm × 57·15 mm
Exposure time: 1/100 and 1/200 sec
Film size: 70 mm double perforation to British Standard 2696:1936
Magazine: displacement type, 30 m or 60 m capacity
Shutter: between-lens
Heater: 200 W thermostat control
Power: 25–29 V dc. Motors 4 A

Type 650 film processor

The Type 650 is a high-speed compact processor capable of being mounted in a small military vehicle. The unit processes two strands of 70 mm or 127 mm wide film simultaneously at speeds up to 10·7 m/min (35 ft/min). Within two minutes clean and scratch-free film is made available for interpretation. A single strand of 241 mm wide film can also be processed.

Specification
Weight: 177 kg (391 lb)
Power: 5 KVA at 240 V ac, 50 Hz
Compartments: 8 wet tanks, 1 dry compartment
Processing speed: Variable up to 10·66 m/min (35 ft/min)
Processing data: Dependent on film and developer
Dimensions: 1·14 × 1·2 × 0·71 m (45 × 47 × 28 in)

Type 652 interpretation table

Any width of film can be viewed on this table. The film is driven in either direction by variable-speed motors over an illuminated table. To aid viewing, travelling microscopes/stereoscopes may be used. Information may, if required, be relayed via a mensuration unit to a computer (as illustrated) thus saving even more time in assessing target data.

Specification
Weight: 250 kg (550 lb)
Light source: Fully variable
Film drives: Fully variable up to 30·5 m/min (100 ft/min)
Viewing area: 0·6 × 1·06 m (24 × 41¾ in)
Dimensions: 2·1 × 0·74 × 0·76 m (82½ × 29 × 30 in)

Universal reconnaissance pod

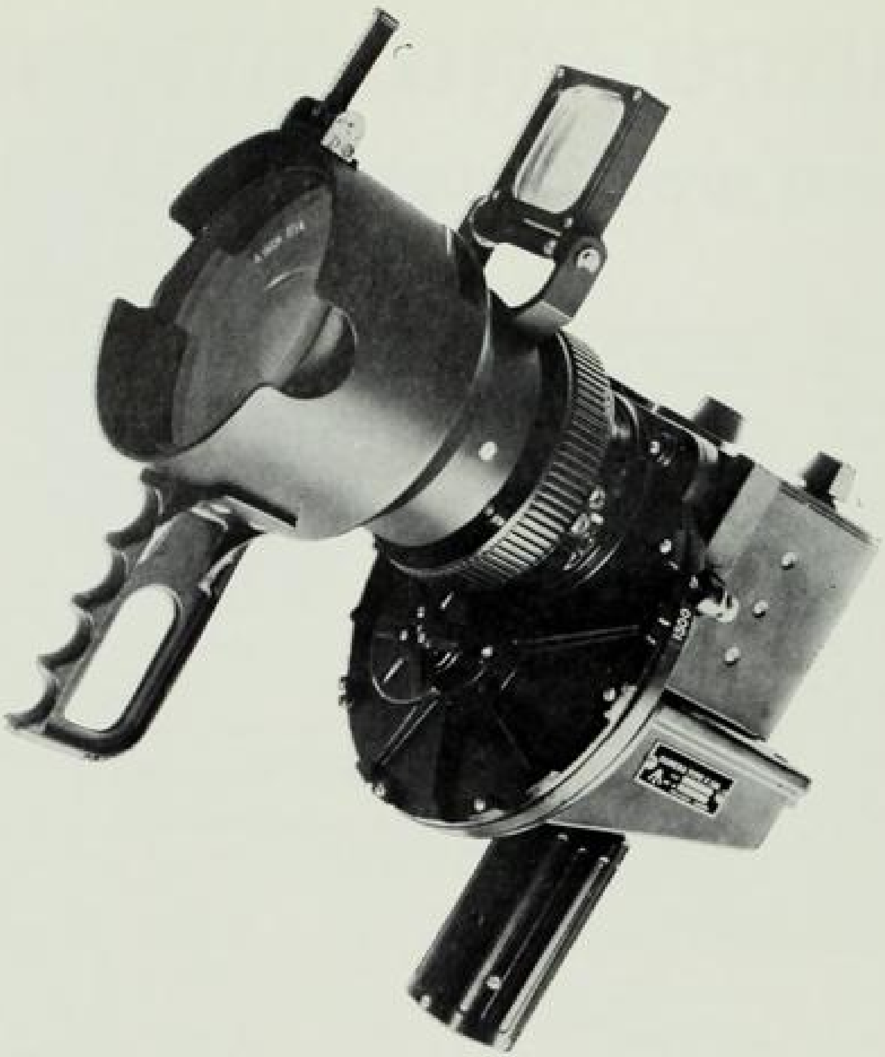
A universal photo reconnaissance pod is available from Vinten, containing a fan of five low-level cameras giving complete horizon-to-horizon coverage. If required, a fan of cameras suitable for medium to high-altitude reconnaissance can be fitted. A pod can be supplied with any known attachment; special attachments can be produced on request.

Specification
Length: 2·4 m (94½ in)
Diameter: 0·456 m (18 in)
Weight fully equipped: 114 kg (251 lb)
Speed capability: Supersonic
Acceleration: 5 *g*
Mounting: Fuselage centre-line or under-wing pylon

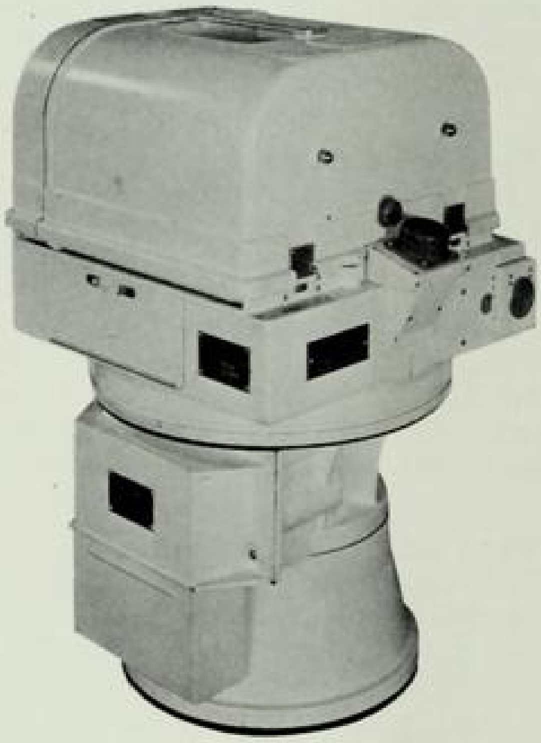
W VINTEN LIMITED
Aviation Equipment Division
Western Way, Bury St Edmunds, Suffolk, England
Telephone: Bury St Edmunds 2121 Cables: Vintacinni Bury St Edmunds Telex: 81176

Vinten

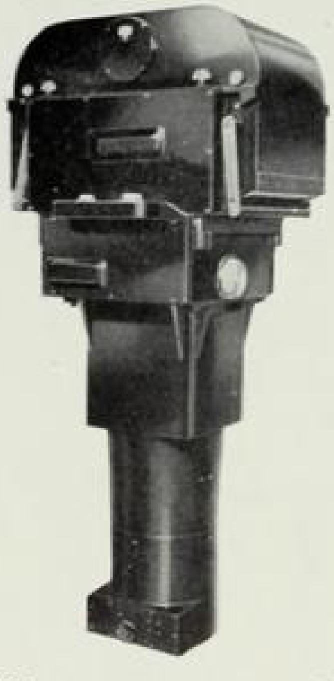
1967



The Williamson F134 hand-held air camera presents no installation problems, either structural or electrical. The 70mm film can be processed on normal portable equipment



The F49 Mk IV air survey camera has image quality and location standards fully matching those of established aerial survey cameras. It is designed for use with first-order plotting machines



When F96 cameras are mounted in banks for high-altitude reconnaissance, each camera is directed at a different angle to the ground, with its picture area slightly overlapping that of its neighbour

Cameras

for reconnaissance and air surveys

The Williamson F134 air camera is in service with the Royal Air Force in the latest marine reconnaissance aircraft, and is in fact the first camera specifically designed for this particular function. It is hand-held and spring-operated, and incorporates a unique rotary focal-plane shutter permitting image stopping speeds of 1/1500sec. Twelve photographs can be taken in rapid succession at one winding, and with detachable magazines one hundred 56 × 56mm (2¼ × 2¼in) photographs can be taken either in black-and-white or in colour. By taking full advantage of the scaled-down techniques of large air cameras, optimum picture definition is ensured. Spring operation means that the camera can be used more or less in any aircraft with sufficient stowage space, so that even helicopters or light aircraft can be adapted for reconnaissance work at very little notice.

The F96 camera is the standard high-altitude day reconnaissance camera of the Royal Air Force. It is specifically designed for mounting as one of a bank of cameras but may also be used singly.

The camera is built on the sub-unit principle and is operated by a combination of electrical and mechanical interlocks. It has a selection of interchangeable lenses and magazines and incorporates the system known as Image Movement Compensation (IMC) which is essential in aircraft flying at high speeds or at low altitudes.

The camera is fully automatic with remote or automatic exposure, remote IMC control and remote (or manual) iris selection.

The Williamson F49 Mk IV air survey camera is designed for use with first-order plotting machines. The new 152mm (6in) f/5·6 Wray survey lens gives high resolution with minimal distortion and greatly improved marginal illumination, and is fully corrected to permit maximum use of colour and infra-red photography without any shift in focus.

Aperture and shutter speeds are remotely controlled and exposure is by a Williamson Intervalometer, supplying an electrical pulse to the camera at a minimum five-second time interval.

The camera's high resolution permits operation at increased altitude and, accordingly, a reduction in the number of exposures required. Since radial distortion is virtually eliminated, any subsequent mapping from the photography entails minimal ground control.

Specification

F134 hand-held camera
Format: 56mm × 56mm (2¼in × 2¼in) on 70mm wide film
Magazine: 7·6m (25ft) 100 exposures
Lenses: interchangeable—100mm (4in) f/1·8, 300mm (12in) f/4
Filter: minus blue
Shutter speeds: 1/250, 1/500, 1/1000, 1/1500sec
Weights: fully loaded with 100mm lens = 5·5kg (12½lb); 300mm lens = 5·9kg (13lb)

F96 camera
Format: 228mm × 228mm (9in × 9in) with instrument strip on 240mm (9½in) wide film
Interchangeable lenses: 1219mm (48in) f/8 telephoto, 914mm (36in) f/6·3 telephoto, 610mm (24in) f/6·3, 305mm (12in) f/4·5, 152mm (6in) f/5·6 Fitted with minus blue filter
Interchangeable magazines: 305m (1000ft), 152m (500ft) and 76m (250ft) capacities for film wound on international standard spools
Shutter: focal plane self-capping interchangeable blinds with speeds of 1/500, 1/250, 1/125sec. Facility for halving the shutter speed remotely is provided
Minimum exposure interval: 1·8sec
Image movement compensation speeds: 0 to 51mm (0 to 2in) per second
Aperture control: manual or remote
Camera record: (1) Master counter records number of pulses to installation; (2) Individual camera counter records number of camera exposures
Temperature range: within specified accuracy between 0 and 30°C, will function between −20°C and +50°C; will not be deranged between −40°C and +70°C
Operating altitude: the camera optical system may be focused to provide optimum performance within any altitude corridor, normally between 12 200m (40 000ft) and 16 800m (55 000ft)
Climatic conditions: to the appropriate specifications for airborne equipment issued by the Ministry of Technology
Electrical supplies: model selected dependent on aircraft electric supply. Camera functions within specification when subject to normal aircraft voltage fluctuations
Weight: varies from 76kg for 305m (168lb for 1000ft) magazine with 1219mm (48in) lens to 40kg for 76m (89lb for 250ft) magazine with 152mm (6in) lens

F49 Mk IV camera
Format: 228mm × 228mm (9in × 9in) with instrument strip on 240mm (9½in) wide film
Instruments: counter, master counter, data tablet
Register glass: Reseau glass consisting of 1cm spaced crosses accurately positioned so that the maximum error of each cross from its true position in a grid is 0·005mm. The Reseau glass is calibrated to give the true position of each cross to an accuracy of ±0·001mm
Shutter: Williamson continuously rotating between-lens shutter having remotely selected shutter speeds of 1/250, 1/350, 1/500, 1/750 and 1/1000sec
Magazine: 76m (250ft) for 300 exposures
Lens: 152mm (6in) f/5·6 Wray survey lens supplied with full calibration data. Fully corrected for colour photography
Filter: minus blue
Iris: remotely selected aperatures of f/22, f/16, f/11, f/8 and f/5·6
Electrical supply: 28V dc
Temperature range: +5°C to +25°C
Weight: fully loaded 75kg (165lb)

A member of the Negretti & Zambra Group
WILLIAMSON MANUFACTURING CO LTD
Hawthorn Road, London NW10, England
Telephone: 01-459 0073 Cables: Kinetogram London NW10 Telex: 25842

WILLIAMSON

Infra-red Linescan

for aerial reconnaissance and survey

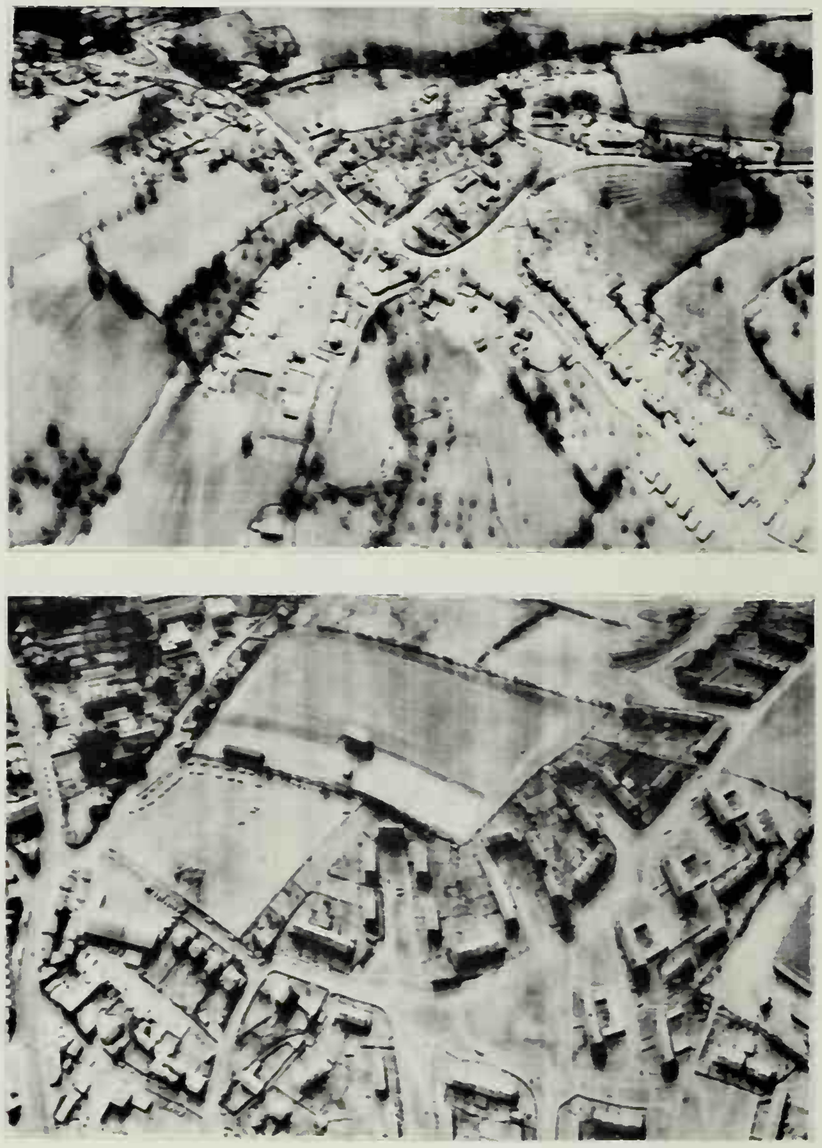
Hawker Siddeley Dynamics has been involved in the design, development and production of infra-red devices since 1950. Two generations of air-to-air infra-red homing missiles and a comprehensive range of single and multi-beam fuzes have been developed. This experience in advanced infra-red and electronic technology is now being applied to Linescan.

Infra-red Linescan is an airborne reconnaissance equipment. It detects, and records on photographic film, minute variations in infra-red radiation. Since all objects emit infra-red radiation according to their absolute temperature and emissivity, a comprehensive thermal picture of terrain overflown is obtained. Radiation occurs at all times, making day and night operation possible without the use of artificial illuminants. Linescan complements conventional photography by providing information that cannot be obtained by conventional cameras.

The Type 201 equipment is designed for use in helicopters, light aircraft, surveillance drones and the relatively slow-flying aircraft used in aerial survey work. The scanner has a field of view of 60° across track either side of the vertical. This gives a coverage of just over 1000 m for an aircraft flying at 300 m. The along-track coverage is a function of the amount of film carried and the operating height. The magazine holds 4·9 m (16 ft) of standard 70 mm film. At an altitude of 300 m (1000 ft) this provides for an along-track coverage of 64 km (40 miles). Magazines are interchangeable and can be easily detached without removing Linescan from the aircraft. A self-test facility which checks all major components for correct functioning prior to operation is incorporated.

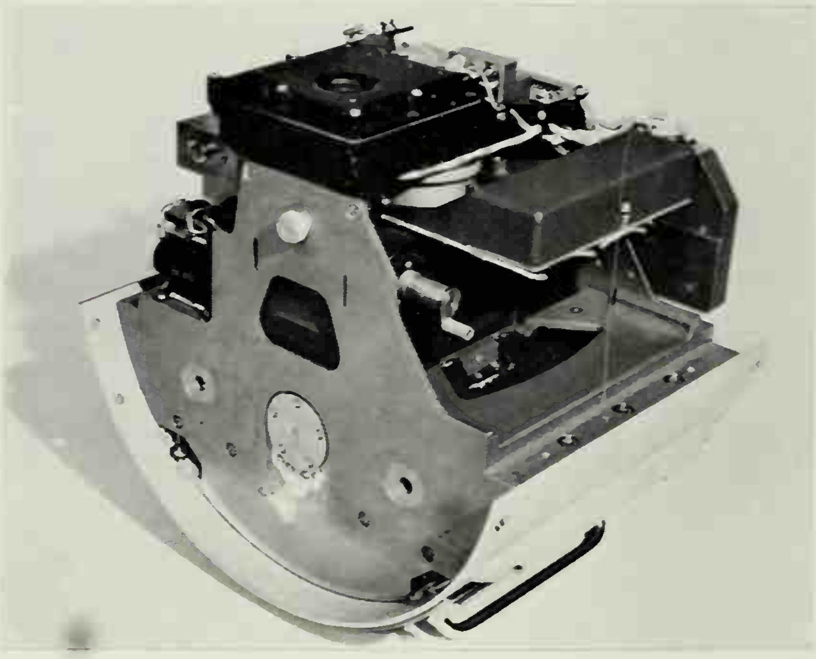
Type 401, on the other hand, is equipment for near-sonic reconnaissance missions at very low level. Compatibility with high-performance aircraft is met by robust construction, the introduction of high-pressure air cooling for the detector, and greatly increased film capacity. To cater for the high velocity-to-height ratio (V/H), a multichannel detector and electronic system is employed. This ensures that a high resolution is maintained over the performance range. Pilot workload is minimised by automatic control of film and scanner speed for V/H, and by roll stabilisation which permits high angles of bank without loss of continuity on the film. Flight navigation data is recorded on the film automatically.

The Type 601 is intended for a wide range of military and commercial survey applications. This single-channel set with its cooling pack weighs only 16 kg (30 lb). It carries 24 m (80 ft) of 70 mm film, giving an along-track coverage of 1250 km (780 miles) at an altitude of 1250 m or 250 km (156 miles) at 250 m.



Above: examples of imagery

Below: Linescan Type 201



Specification

Type 201
Dimensions: 264 × 330 × 318 mm (10·4 × 13 × 12·5 in)
Weight: 11·6 kg (25 lb)
Resolution: 1·5 milliradians
Sensitivity: < 0·25°C
Spectral response: 8–14 microns
Velocity-to-height ratio (V/H): 0·15 – 0·75 radian/sec
Along-track coverage: 60 km (40 miles) at 300 m (1000 ft)
Across-track coverage: 120°
Cooling endurance: 30 min
Power requirements: 6 A at 28 V dc
Film capacity: 4·9 m (16 ft)

HAWKER SIDDELEY DYNAMICS LIMITED
Manor Road, Hatfield, Hertfordshire, England
Telephone: Hatfield 62300 Telex: 22324

Section 20

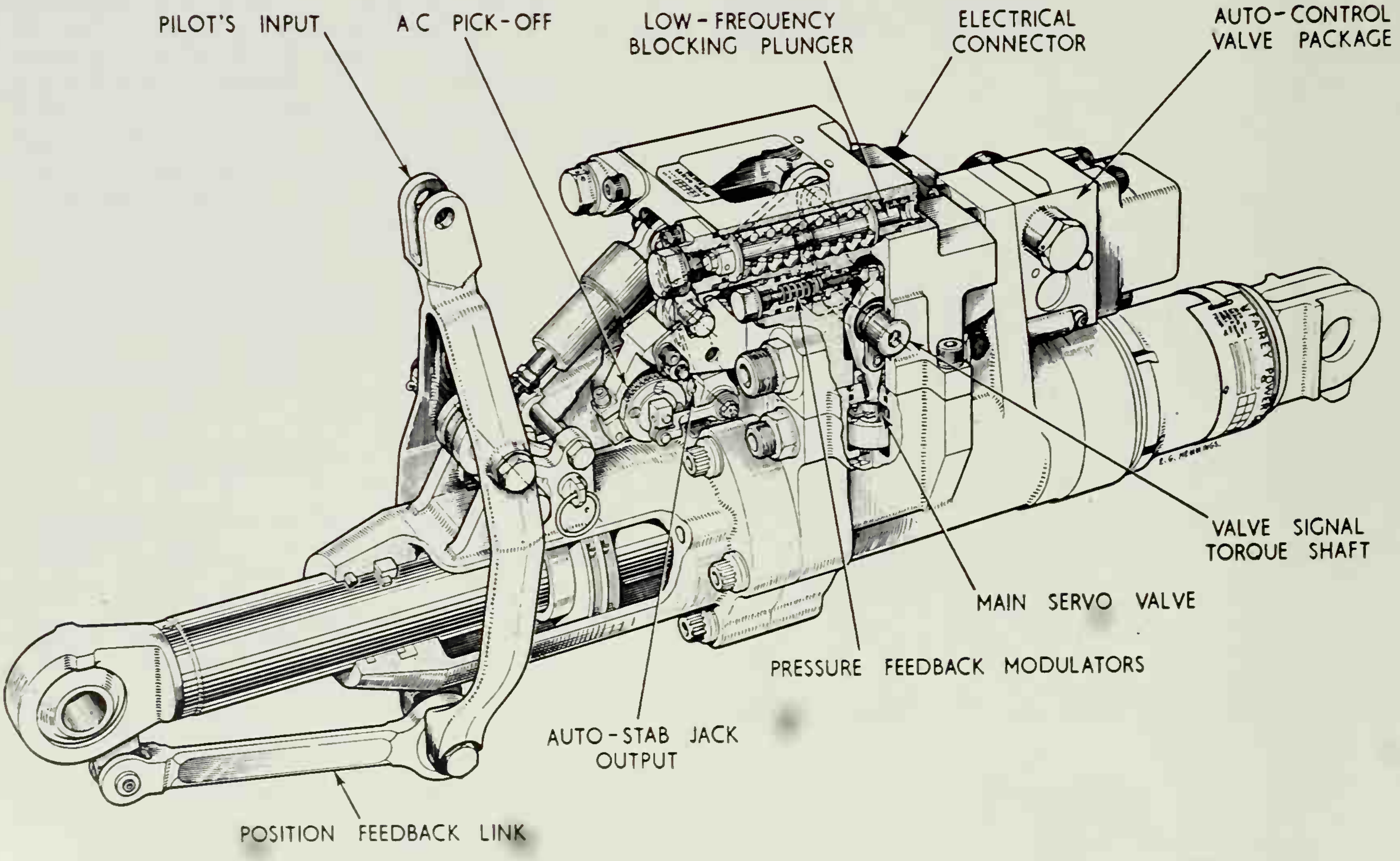
Aircraft equipment and instruments

Power controls

for strike and transport aircraft and helicopters

Power-assisted actuation of the control surfaces of modern military aircraft is essential. In addition to minimising the pilot effort required to manoeuvre high-speed aircraft, power-assistance also facilitates automatic stabilisation of the aircraft. Fairey Hydraulics powered control systems have been fitted to many military aircraft since the first control units flew in 1945. These aircraft include the Hawker Siddeley Hunter, English Electric Canberra and Westland Belvedere. Currently Fairey is supplying the power controls for the following European military aircraft: Hawker Siddeley Harrier, Breguet/BAC Jaguar, Fiat G91Y, Fiat G222, Westland WG13. The company is also closely concerned with proposals for the advanced power-control system for the Panavia 200 multi-role combat aircraft.

The Fairey power control system for the Jaguar strike fighter is typical of the company's products. This aircraft is fully power-controlled on all three axes without manual reversion. Auto-stabilisation is available acting on the yaw and pitch axes and, when selected at high speed, frees the pilot from the need for constant minor corrections to attitude; it also makes the aircraft a more stable weapons platform. Changes in the aircraft's attitude are sensed by its inertial platform and corrections are fed to the power controls in the form of electrical signals. A key factor of the power controls is the way in which a wide range of system components has been combined in single integrated actuator packages. This produces a simple system with a minimum of pipework and wiring, a single access door for each power control unit, faster trouble shooting and low battle vulnerability.


PILOT'S INPUT
A C PICK-OFF
LOW-FREQUENCY BLOCKING PLUNGER
ELECTRICAL CONNECTOR
AUTO-CONTROL VALVE PACKAGE
VALVE SIGNAL TORQUE SHAFT
MAIN SERVO VALVE
PRESSURE FEEDBACK MODULATORS
AUTO-STAB JACK OUTPUT
POSITION FEEDBACK LINK

Jaguar tailplane power control

Hydraulic filters

for aircraft and ground use

Based on more than 20 years' experience, the Fairey Hydraulics range of aircraft hydraulic system filters has a combination of housings and filter media capable of meeting the most exacting demands of modern military aircraft. Filtration is a specialist branch of aircraft engineering which has a considerable effect on an aircraft's economy and reliability in service. The need for adequate filtration extends to the ground rigs used to service hydraulic equipment and a range of filters is available for this purpose. The increasing complexity of the hydraulic systems used in armoured fighting vehicles and other military equipment is providing a new range of applications for Fairey's service-proved filtration equipment.

The parts which are particularly in need of protection are hydraulic pumps, powered flying controls (especially the servo valves), selector valves and actuators.

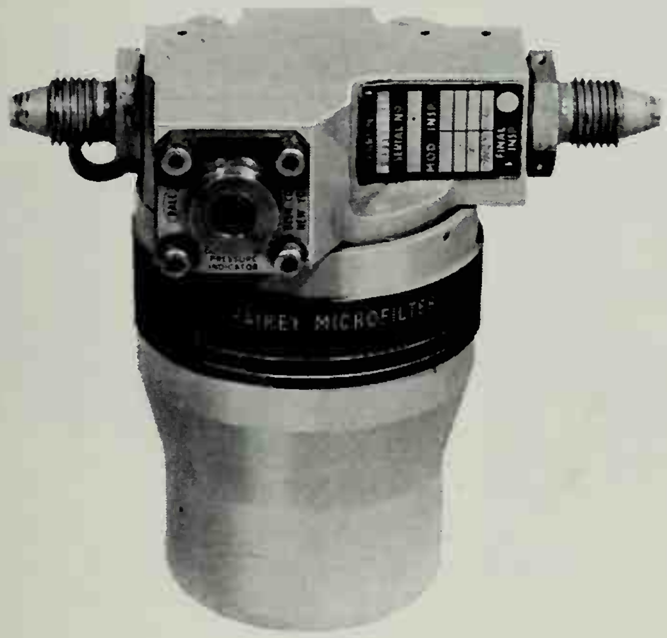
They need protection against manufacturing debris, introduced contaminant, generated contaminant, contaminant resulting from break-up of a component and against substances formed by decomposition of fluid.

Fairey's choice of filter media covers the requirements of the five principal filter locations:

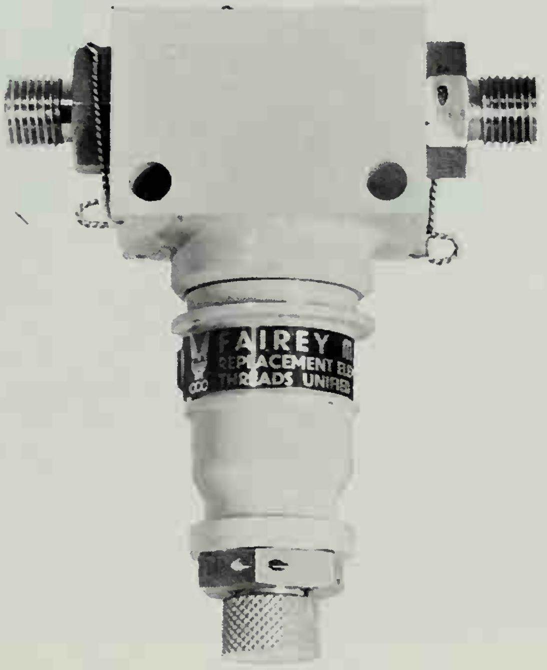
1. Fine filtration down to 15 micron in the high-pressure delivery line immediately downstream of the pump for general system protection.
2. Tubular or disc-type filters in the 75 to 200 micron range at the inlet to each critical component as a protection against gross contamination.
3. Ultra-fine filtration, to 3 micron and better, in the main return line for maximum system cleanliness.
4. Standard filtration to 45 micron in the drain line of constant-pressure pumps.
5. Coarse strainers—100 to 200 micron—in the pump suction line to protect the pump against large particles.

These micron ratings are typical values.

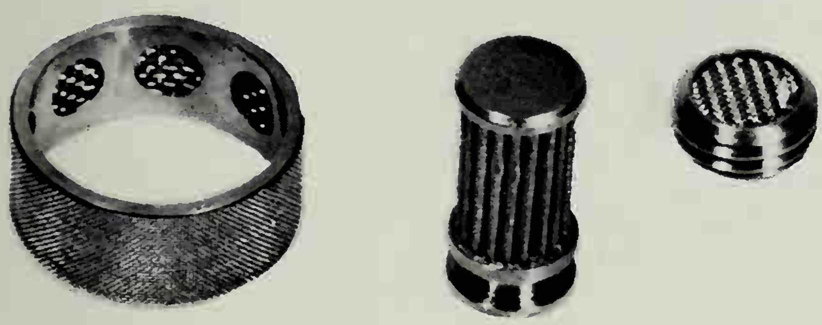
Full technical data sheets, the publication Filtration for Aircraft Hydraulics and information on fluid evaluation services are available from Fairey Hydraulics Ltd.



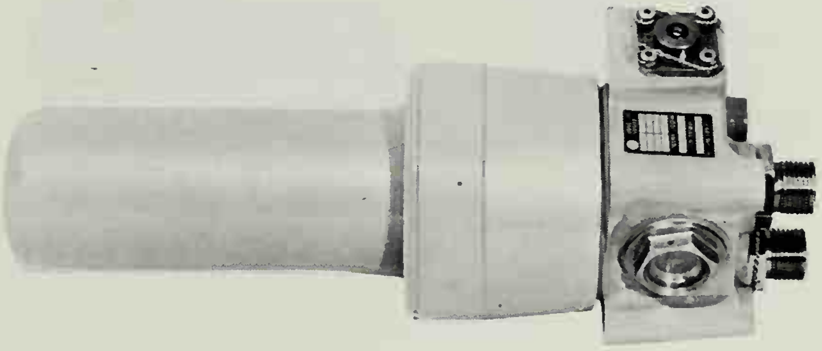
Low-pressure two-stage filter. Primary stage rating: 3 micron absolute, secondary stage rating: 15 micron absolute. Fitted to flight refuelling target winch system



Hydraulic pump case drain filter fitted with magnetic chip detection system, as fitted to the BAC 1–11

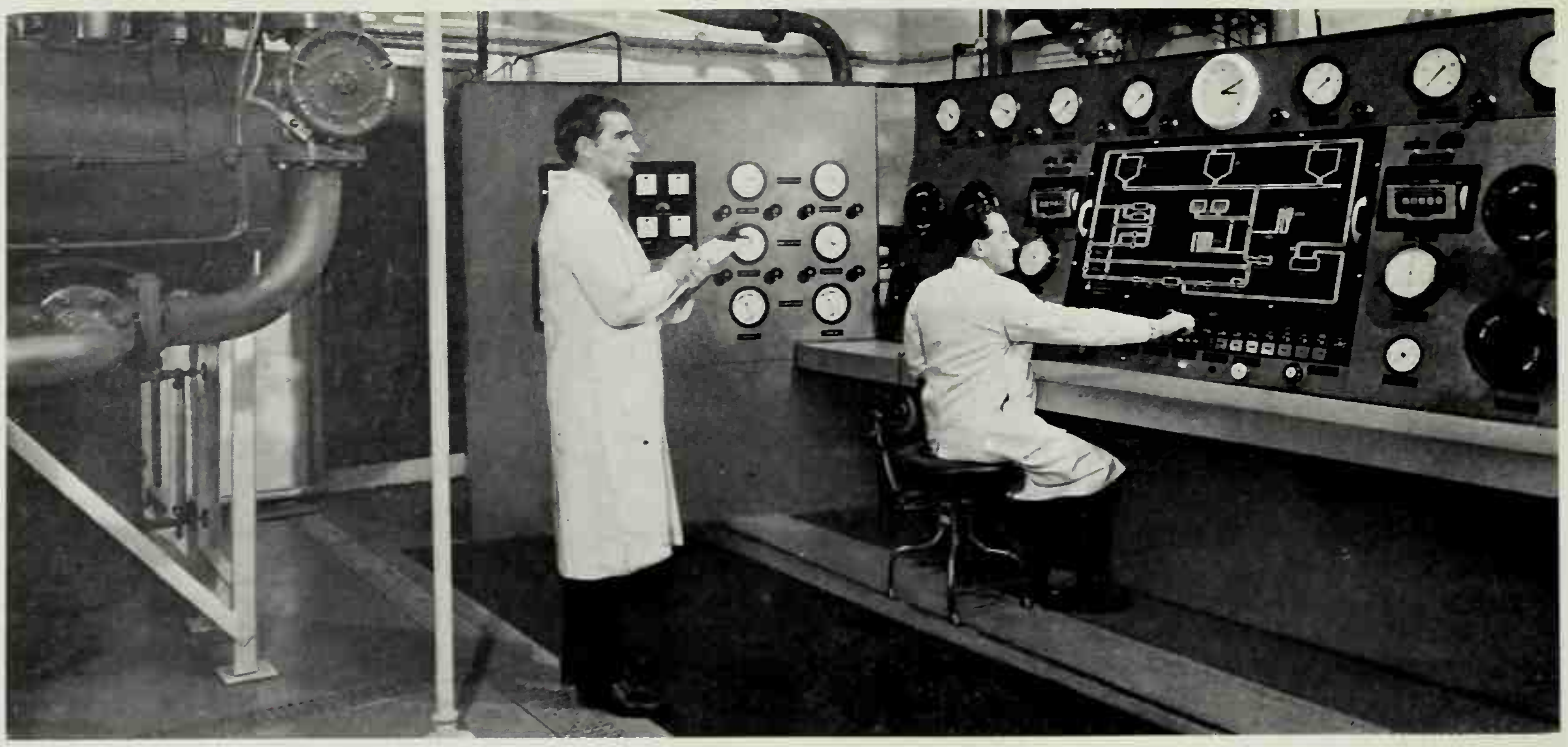


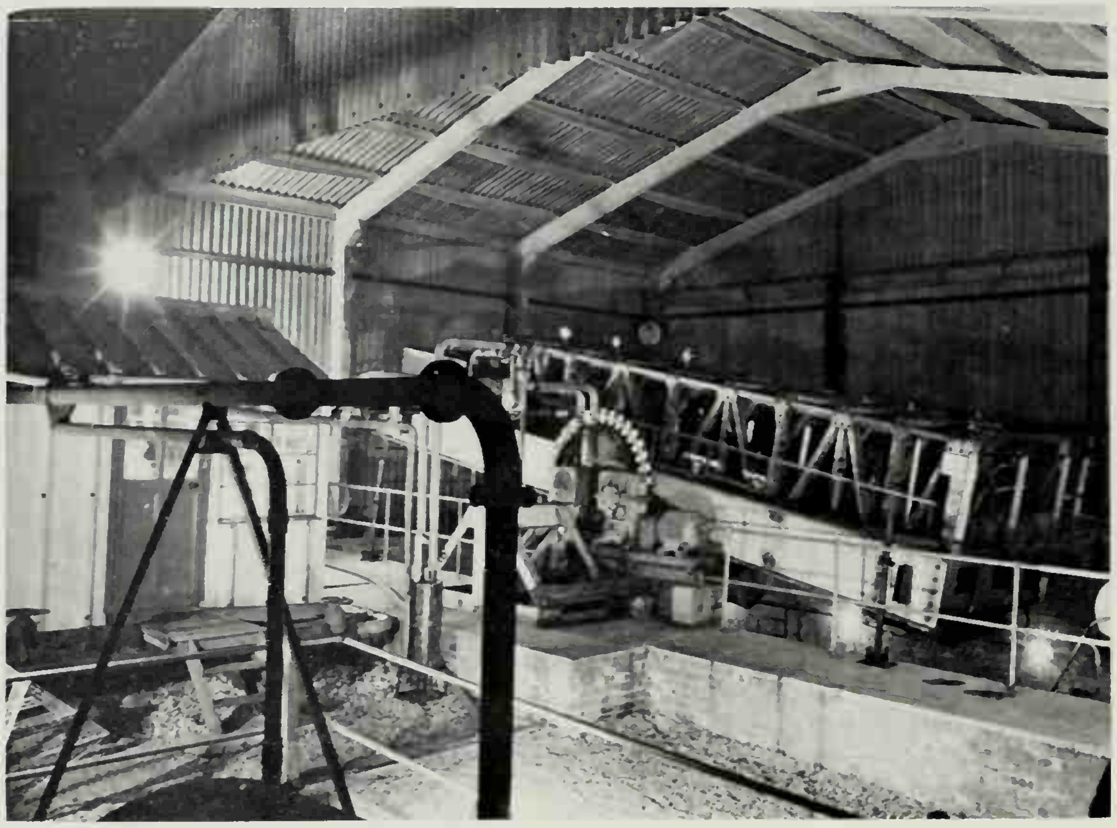
Insert filter elements used to protect individual components



High-pressure T-type filter as fitted to the BAC 1–11

FAIREY HYDRAULICS LIMITED
Cranford Lane, Heston, Middlesex, England
Telephone: 01-573 7777   Cables: Airily Hounslow   Telex: 22230

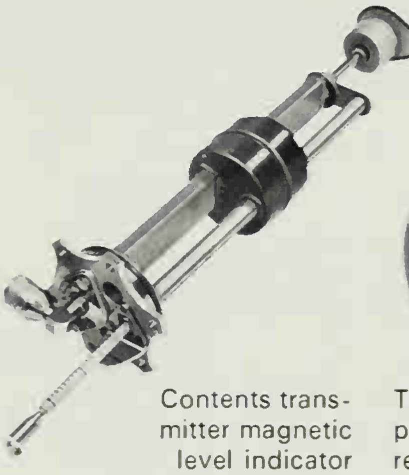




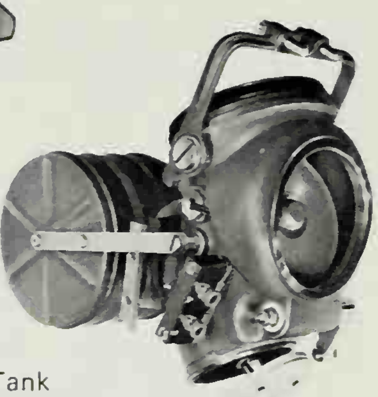
Above: fuel filtration test rig

Left: Buccaneer test rig

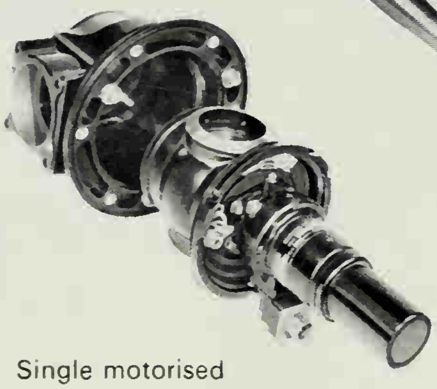
Recirculation pressure-holding valve



Contents transmitter magnetic level indicator



Tank pressure-relief valve



Single motorised plug-in valve

Jet pump

Non-return valve

Engine fuel and oil-drain valve used on RB211 engine

Refuelling valve Mk 48

Fuel systems

and associated equipment

From closed-circuit in-flight refuelling, FR has developed both fuel systems and components for military and civil aircraft.

The company's design experience of 30 years is backed by extensive research and test facilities. The Buccaneer test rig and development fuel test house shown left are indicative of the specialised nature of the work being undertaken in fluid system problems.

The FR range covers most types of precision components for fluid control—solenoid valves, motorised and manual control valves, float switches, level indicators, contents transmitters, vent valves, jet pumps, pressure controllers, pipe couplings and fuelling couplings.

Flight Refuelling manufactures a wide range of control valves for refuel, defuel, jettison and transfer based on the pressure differential principle. Standard methods of operation are by solenoid valves, or float-operated sensor valves. Control valves of the spherical plug type (manual and motorised) also cover these applications as well as low-pressure engine feed, APU feed, fire shut off, etc.

Variants of these designs provide for fully submerged or plug-in application, fail-safe open or closed functioning, electrical indication of flow or no flow, manual overide and pre-check facility.

A range of jet pumps is also available suitable for inter-tank transfer, reduction of unusable fuel and other purposes. The bleed from a conventional fuel boost pump usually offers a convenient pressure source but any other pressure source can be used. Flight Refuelling's jet pumps are light in weight, simple in construction and contain no moving parts.

Float valves

Vent, relief, air/no fuel, fuel/no air and overflow

This range of valves has been designed to prevent fuel entering the vent system or air entering the fluid system.

They are available in top, side and bottom-mounted variants and can have electrical indication of correct functioning.

Non-return valves

The wide range of non-return valves covers all known aircraft fuels and fluids and can accommodate any type of pipe connection.

Both in-line and hinged flap designs are available with both rubber/metal and metal/metal sealing features.

Special requirements such as pressure relief, constant pressure or constant flow characteristics are possible with the basic design parameters.

Pipe couplings

A complete range of flexible pipe couplings is produced for pipe-to-pipe and pipe-to-component connection. Stainless steel lightweight shields are available to increase the fire resistance of the couplings.

Fluid measurement

Float switches

The FR range of float-operated liquid level switches employs encapsulated reed switches or microswitches for high- and low-level indication and is suitable for operating electrically actuated components and indicator light systems.

The switches are light, simple in construction, and suitable for tank-mounting.

Contents transmitters

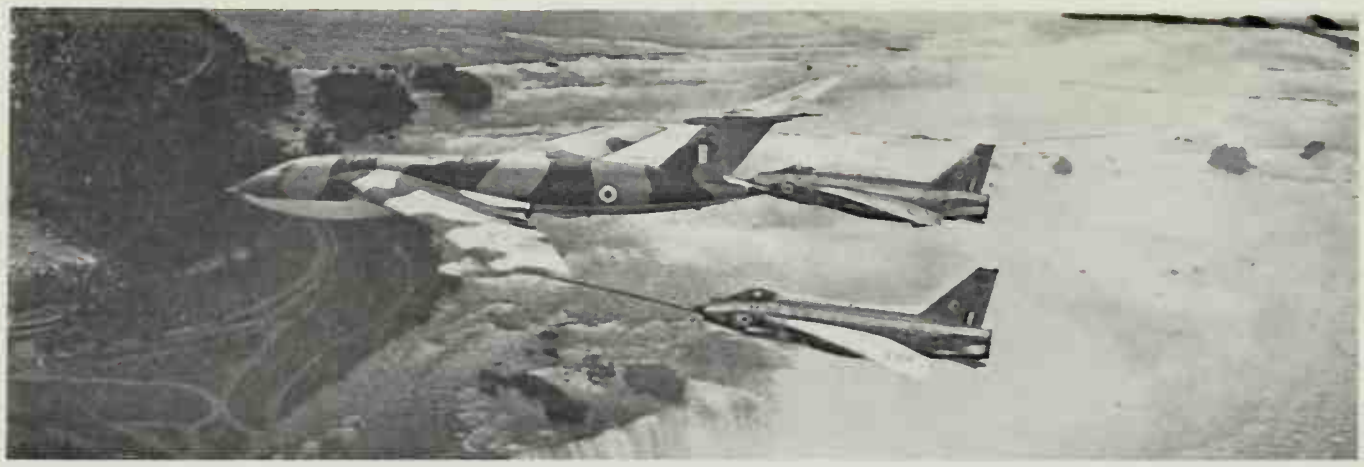
Again using encapsulated reed switches, these float-operated contents transmitters offer progressive indication on remote indicators or on conventional voltmeters or ratiometers suitably graduated.

Magnetic level indicators

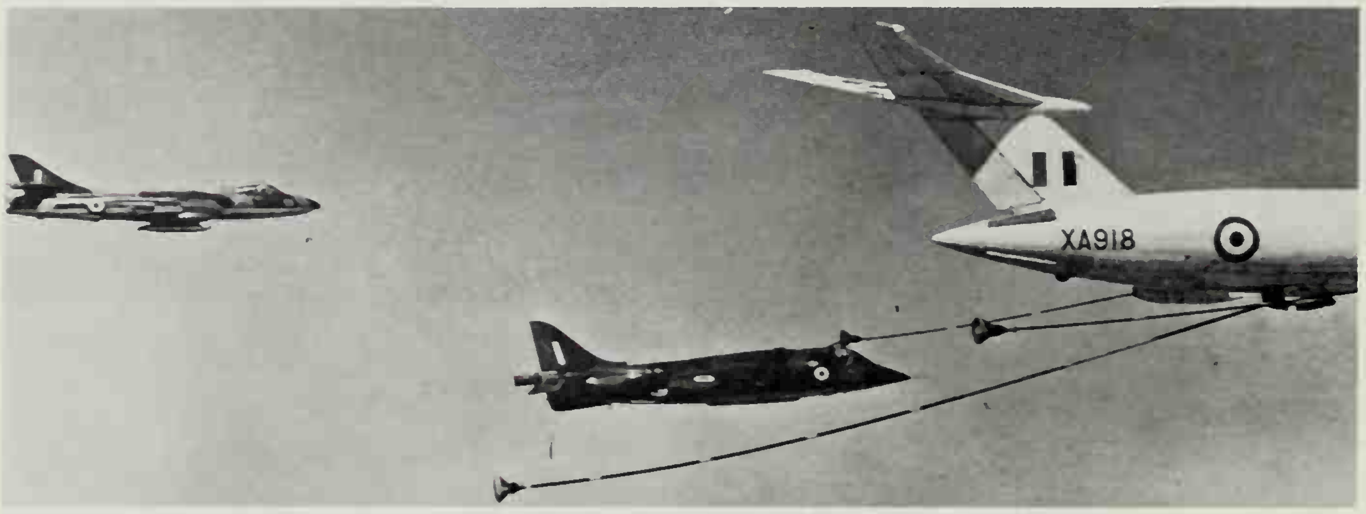
These are dripless type tank-mounted dip-sticks for tank contents ground checks without risk of spillage.

FLIGHT REFUELLING LIMITED
Wimborne, Dorset, England
Telephone: Wimborne 2121 Cables: Refuelling Wimborne Telex: 41247

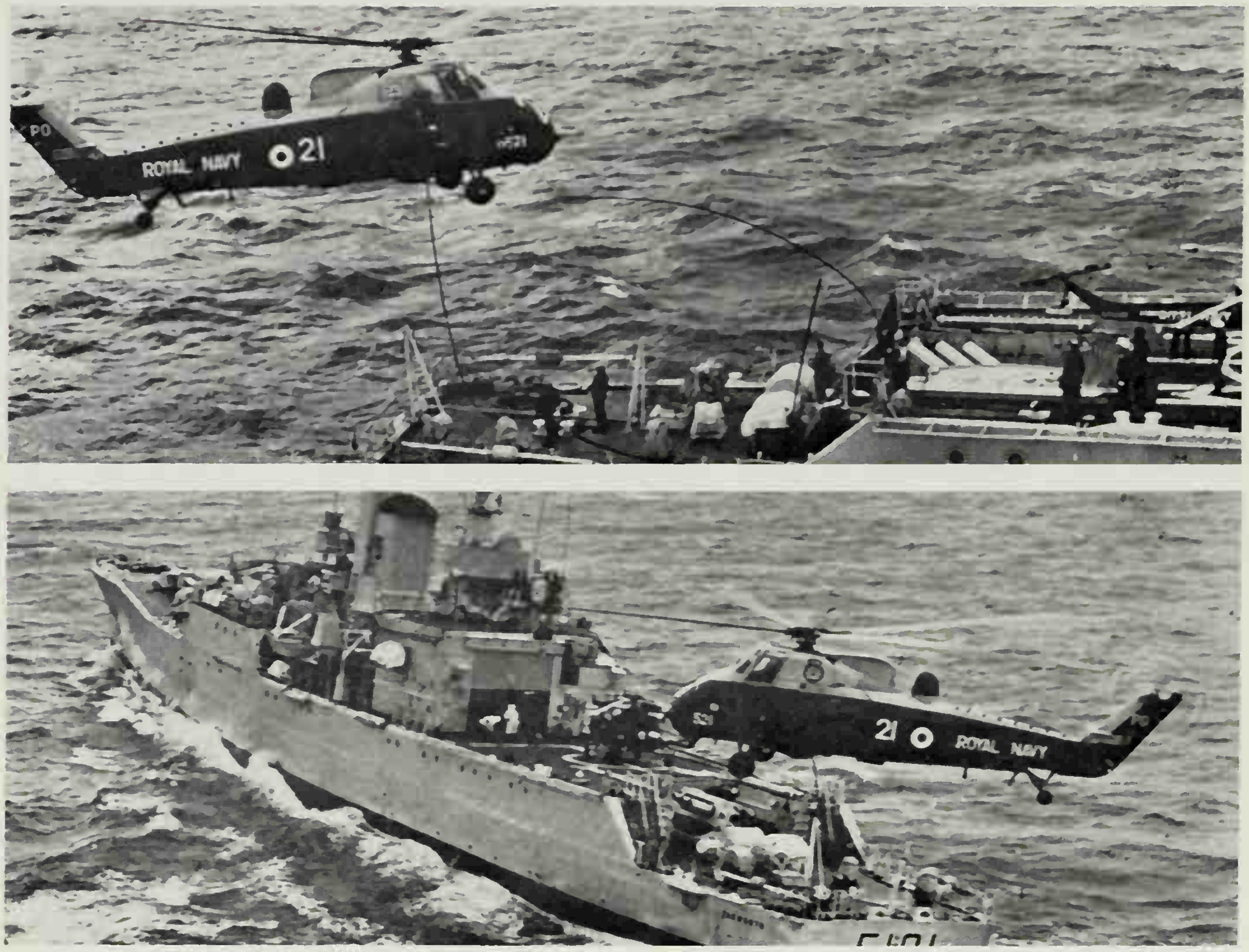
FR



A Victor tanker aircraft refuelling two Lightning fighters simultaneously in flight



A Harrier fighter being refuelled in flight by a Victor tanker aircraft



Two views of a Wessex helicopter being refuelled in the air at sea by HMS *Yarmouth*

An Army Scout helicopter being refuelled on the ground with its rotors turning

Refuelling systems

for aircraft and helicopters

Flight Refuelling Ltd was formed in 1934 by Sir Alan Cobham to develop the techniques of refuelling aircraft in flight and today the company's probe-and-drogue system of in-flight refuelling is in service with the Royal Navy, the Royal Air Force, the Royal Australian Navy and the South African Air Force and is also used by the US Navy, US Marines, US Air Force, the French Navy and French Air Force and other military services.

More recently FR, with the backing of extensive research and test facilities, has developed and perfected its system of refuelling helicopters—on the ground or in flight—with or without rotors turning—and with full fail-safe protection against error or accident.

In naval use, helicopters can be refuelled ship-to-air without landing, though the same refuelling equipment can be used for smaller helicopters which can land on deck. Flight Refuelling helicopter refuelling equipment is supplied to the Royal Navy, the French Navy, the Royal Swedish Navy and the South African Defence Force, and several other navies are negotiating for its purchase.

Well-proven system

This navy helicopter refuelling system from ships is service-proven over a number of years. Refuelling has taken place under turbulent wind conditions in excess of Beaufort wind scale Force 8 and at night, in addition to normal day operations.

Full safety measures

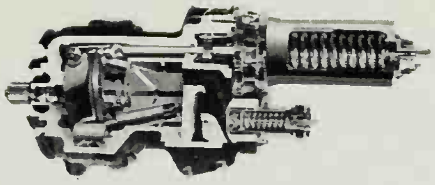
The FR helicopter refuelling systems meet all hazards, and the safety systems operate whether or not the pilot is in control. Here are the principal features of the safety system:

1) FR emergency break units are fitted at the top and bottom ends of the refuelling hose. There are guards against hazard should the helicopter have to break away in an emergency.
2) There is no spillage—refuelling stops automatically when the tank is filled to capacity.
3) An automatic safety device of the 'dead man's handle'-type gives fail-safe break-away in an emergency. The helicopter can take off in any direction, without need to advise the ground crew.
4) There is safe venting of fuel vapour.

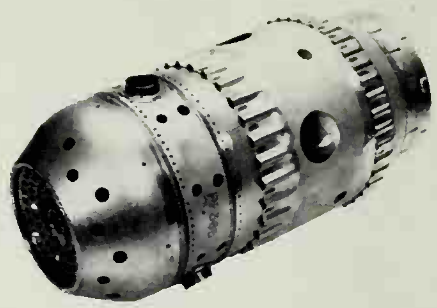
FLIGHT REFUELLING LIMITED

Wimborne, Dorset, BH21 2BJ, England

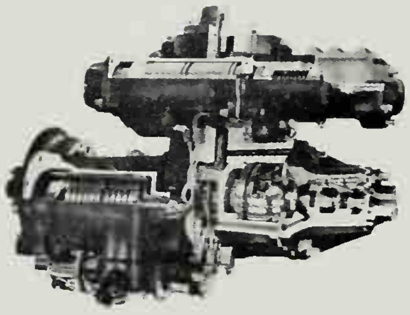
Telephone: Wimborne 2121 Cables: Refuelling Wimborne Telex: 41247



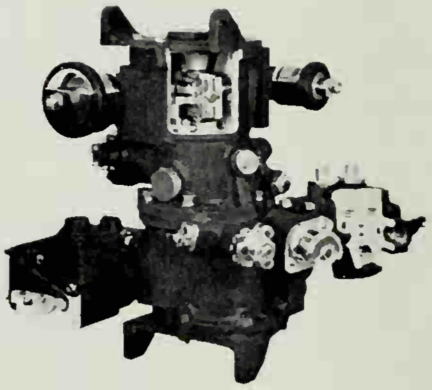
Fuel pump



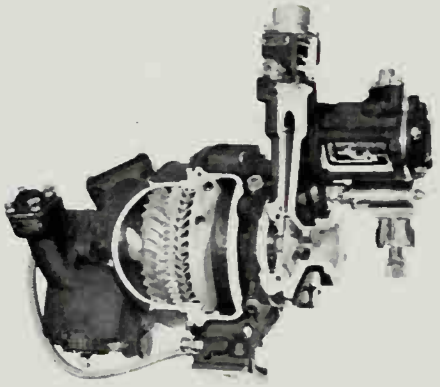
Flame tube



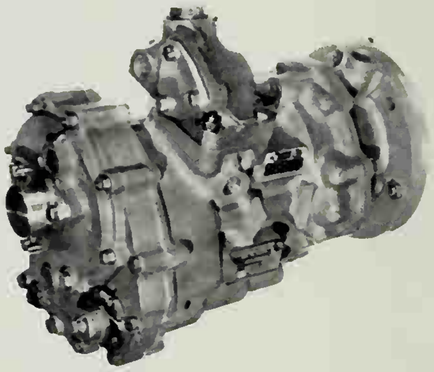
Fuel flow regulator



Hydraulic
intake control

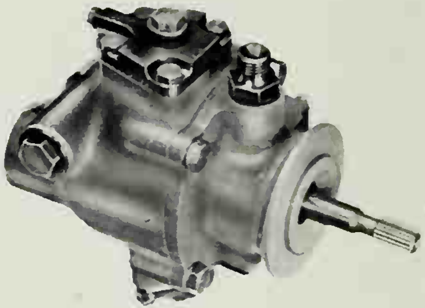


Turbine-driven
CF pump



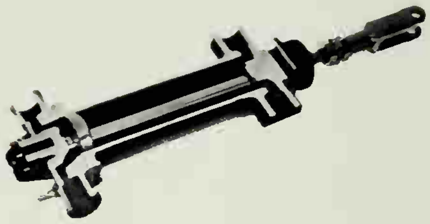
Fueldraulic nozzle
control pump

Transistorised
amplifier

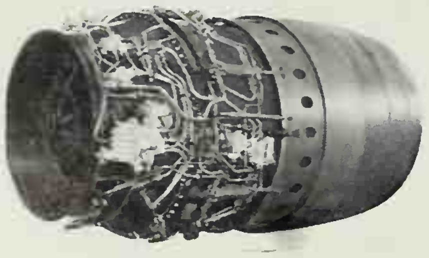


Radial piston
hydraulic pump

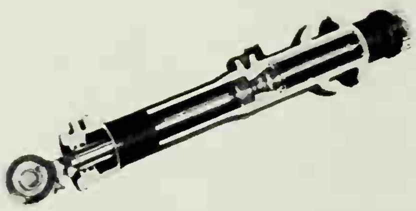
Jet pipe casing



Nozzle control ram



Jet pipe



Variable-intake ram

Fuel systems

and combustion and hydraulic systems

In research, design, development and manufacture, Lucas Gas Turbine Equipment Limited provides a service to the aircraft industries of the world which is truly unique. Lucas has been in the forefront of the evolution of the sophisticated modern aircraft, producing fuel metering systems, combustion systems (using precision fabrications) reheat, nozzle, reverse thrust and intake controls for aircraft gas turbine engines and hydraulic systems for airframes to meet the most exacting requirements, all with total product support.

Aircraft gas turbine engine fuel pumps, fuel systems, control equipment and aircraft hydraulic systems are developed and supplied from the Lucas factories. An illustration of our involvement can be gauged by the example that over 35 000 engine fuel metering sets have accumulated a total in excess of 100 million flying hours.

The fuel control system is, in fact, the vital link—the 'nervous system'—which interprets the pilot's demand for engine power in terms of precise physical quantities of fuel for the required engine response, having computed the effects of environmental influences, altitude, temperature, etc. This imposes a special responsibility on the manufacturer. From 1941, Lucas has understood and discharged these responsibilities with distinction.

In combustion research we engineer, organise and administer design and development of combustion equipment for the latest engines in both supersonic and ultra-lightweight fields. Together with many other projects, very small annular combustion chambers have been designed for gas turbine starters and auxiliary power units. To meet the demands on the combustion system for supersonic engines, yet still retaining high combustion efficiencies over a wide range of operating conditions, exceptional light-up performance and an acceptable life of components operating at considerably elevated temperatures have greatly increased the severity of the problems normally encountered. The thermal and vibratory stresses in the flame tube have also increased as the result of the high pressures and temperatures involved and it has been necessary to introduce new concepts of flame tube construction and to adapt newly developed heat-resistant alloys.

In both research and development, the laboratories continue to remain in the forefront of advanced combustion equipment evolution with examples of more advanced thinking and design. Detailed information on these facilities is covered in supplementary brochures on manufacturing, research and development; the brochures are available on request.

Engine fuel systems

With the newer engines and especially the advanced technology versions employing the third generation design flow control, the combined acceleration and scheduling control unit employs simple non-dimensional parameters for engine control, applicable at any altitude or temperature condition of the engine. Designed for ready adaptation for various aircraft applications, the acceleration control steady-running requirements are met by direct mechanical methods of operation. Continuously rotating ported sleeve valves achieve a considerable reduction in hysteresis when the valve ports open or close and by omitting small control orifices the system is less susceptible to contaminated fuel.

As an alternative to the variable-stroke piston pump and for engines requiring a simple high-speed pump, gear-type units are available.

Combustion systems

Combustion systems created by precision fabrication can be divided into three main categories, the components of which are welded and/or brazed on assembly. These are (a) details from sheet metal; (b) a combination of sheet metal and machined details; and (c) machined details only.

Long experience has shown that it is only by meticulous care, beginning with the selection of the raw material itself, that assemblies of high technical quality and accuracy can be consistently produced. And this experience must be universal throughout design, planning, project development, process control and inspection.

Our engineering capabilities are such that we can undertake the responsibility for the manufacture, build and test of complete major engine assemblies such as Spey reheat jet pipes.

All the sheetmetal components, pipework and hydraulic jacks are of Lucas manufacture.

Hydraulic systems

Some 27 years' experience in the design, development and manufacture of high-pressure fuel systems for aircraft gas turbine engines is the background from which special-purpose aircraft hydraulic systems using fuel as the hydraulic medium have been developed. A demand for a hydraulic duty of this type, which is known as a fueldraulic system, arises when certain circumstances result in its incorporation in the main hydraulic system.

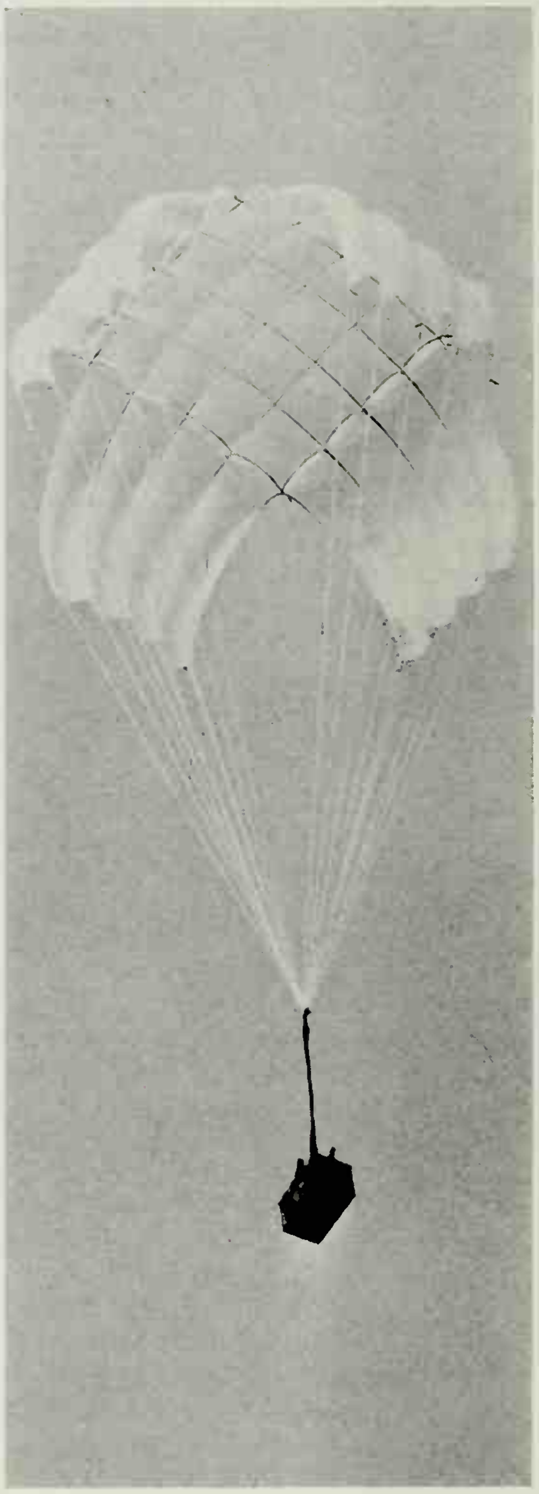
By using high-pressure fuel as the hydraulic medium, the necessity for installing a completely separate system, including storage tank, coolers, boosters, etc, is obviated.

LUCAS GAS TURBINE EQUIPMENT LIMITED
Shaftmoor Lane, Birmingham 28, England
Telephone: 021-777 3232 Cables: Luset Birmingham Telex: 338781

LUCAS

1966
1967
1969

The new GQ 6·7 m (22 ft) shaped diameter, static line-operated fully steerable parachute



The new GQ Unicross supply-dropping parachute, which may be considered expendable but can be used many times

The new GQ synthetic QF/QD seat-type parachute assembly already ordered by the Finnish Air Force

Parachutes

for all purposes

RFD-GQ Limited offers an exceptionally wide range of parachutes for both civilian and military use, for the safe dropping of personnel as well as supplies. Each parachute assembly is designed to give optimum service under specific conditions of use. GQ is approved by the British Ministry of Technology for the design of all types of parachute, all of which are developed in the light of actual field experience in many parts of the world.

Personnel parachutes

The new GQ 6·7 m (22 ft) shaped diameter, static line-operated fully steerable parachute will be in service with British troops this year. It was developed in conjunction with the British Ministry of Technology and its design permits, for the first time, paratroops and para-medic teams to avoid ground obstacles as they land.

The new parachute also uses a new three-point hook and D-ring fastening harness incorporating special shoulder release fittings. These allow the canopy to be collapsed immediately on landing so that the paratrooper is not dragged along prior to releasing his harness. Special D-rings are also fitted to the harness for attaching the reserve parachute and the CSPEP (carry straps, personal equipment parachutist). Both these items are GQ products.

Another new GQ product is the synthetic QF/QD seat-type parachute assembly, which was developed from the seat-type Mk 10 assembly. This new parachute has been ordered by the Finnish Air Force. Synthetic materials replace canvas and flax used for the Mk 10 and the harness has been re-designed to permit fitment of the latest Capewell '1½ shot' shoulder canopy releases. These releases permit the airman to shed his harness quickly, because the canopy can be collapsed immediately on landing.

The advantages of this new parachute, compared with the Mk 10, are:

1 because of the use of synthetic materials throughout, the equipment has a much longer useful life

2 the equipment is more comfortable to wear because the harness can be adjusted more easily

3 divestment is quick and simple by merely releasing the snap hooks

4 even if the parachutist is injured he can activate the Capewell shoulder canopy release to prevent being dragged along after landing

5 the materials are impervious to bacteria and fungal attack, do not rot after immersion in water

Supply-dropping parachutes

Six overseas forces have ordered the new GQ Unicross expendable/optionally re-usable supply-dropping parachute assembly which is undergoing trials with British forces. The six sizes of canopy available offer a cheap method of lowering vital supplies. The load range of the six canopies is:

22·6–68 kg (50–150 lb)
22·6–136 kg (50–300 lb)
68–277 kg (150–500 lb)
317·5–681 kg (700–1500 lb)
681–1044 kg (1500–2300 lb)
453–1135 kg (1000–2500 lb)

The canopies are made from polypropylene and are cheap enough to be expendable. They can also be used many times and any damaged components are replaceable without sewing. They are sufficiently waterproof to be used as covers.

The new parachutes described here are supplementary to the well-established range of GQ utility supply-dropping parachutes. With their viscose rayon canopies they are capable of landing loads from 45 kg (100 lb) for the 4·3 m (14 ft) assembly, to 1180 kg (2600 lb) for the 18·3 m (60 ft) assembly. With the GQ 20·1 m (66 ft) supply-dropping parachute assembly in its single and cluster versions capable of lowering loads of up to 2040 kg (4500 lb) per canopy, our claim is 'GQ parachutes can lower any known load from any known aircraft'.

RFD-GQ LIMITED
Godalming, Surrey, England
Telephone: Godalming 4122 Cables: Airships Godalming Telex: 85233

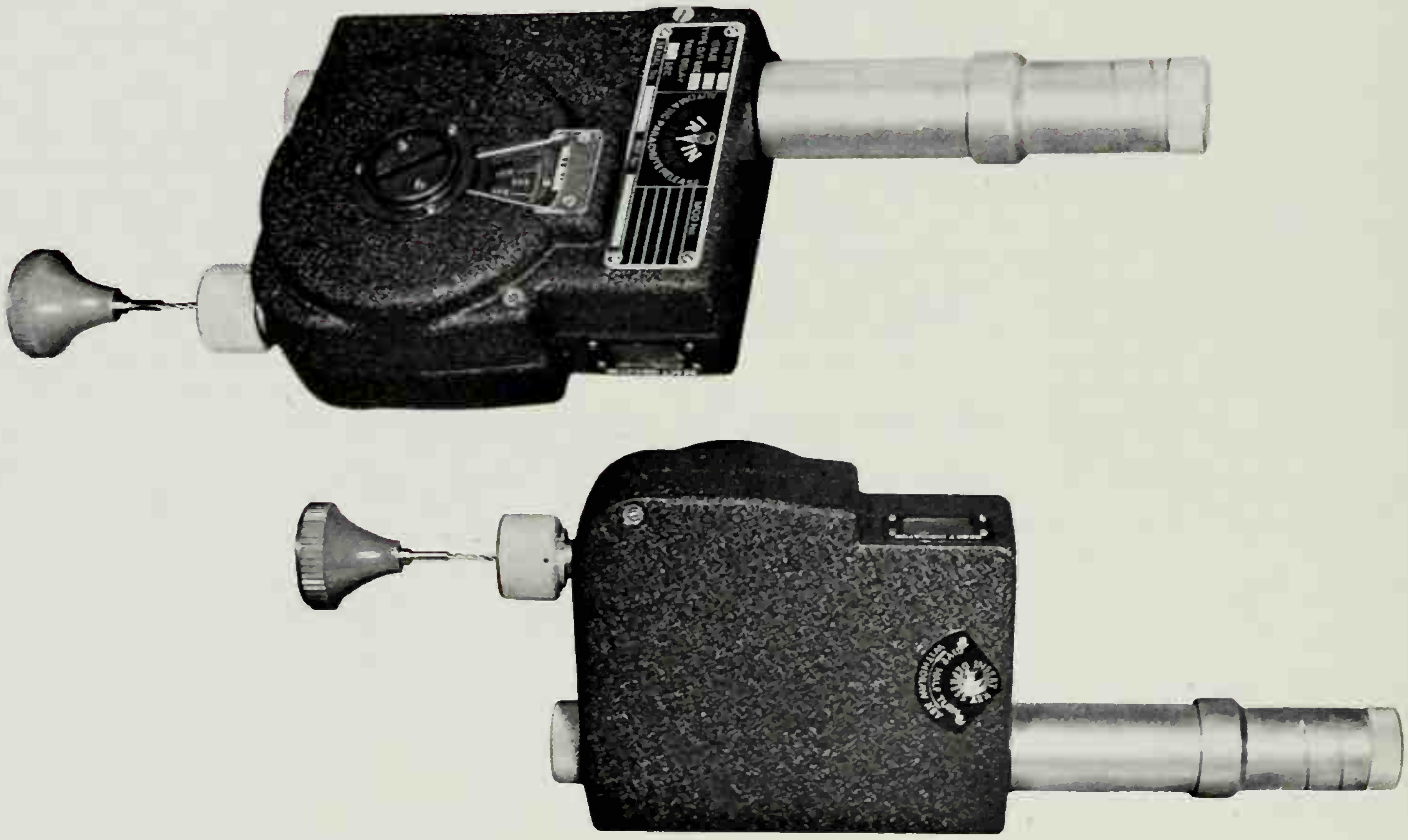
Automatic release

for parachutes

The Hitefinder automatic parachute release Type D/1 Mk 2 is designed to open a free-fall parachute in the event of the user failing to pull the ripcord handle at or above the minimum safe opening height.

Pre-setting of the Hitefinder to operate at a selected height is a straightforward operation requiring the adjustment of one dial graduated in millibars. The pre-setting operation is done in conjunction with a special calculator provided with the instrument and the only information required by the user is the ground level pressure prevailing at the DZ (dropping zone). Having registered the DZ pressure reading on the calculator, the pressure equivalent to the required parachute opening height can be quickly determined, without further adjustment of the calculator, and set up on the dial of the Hitefinder.

Before jumping, the parachutist withdraws an arming pin, either manually or by static line, to enable the Hitefinder to operate at the pre-set pressure. The operating sequence is initiated during descent by an aneroid capsule which progressively contracts because of increasing atmospheric pressure. At a specific height above the operating height the aneroid capsule collapses to a point where a time delay mechanism powered by a compression spring is freed. At the termination of the time delay, the compression spring is released to provide the motive power by which means the rip pins are withdrawn and the parachute is opened. The time delay is provided to ensure that when a jump is made at or below the height at which the Hitefinder is set to operate, the parachutist is well clear of the aircraft before the canopy deploys. The Hitefinder can also be embodied in non-man-carrying parachute systems and is particularly ideal for use where delayed opening of a canopy at a specific height above ground level is required.



Specification

Weight and dimensions
Total weight: 680 g (24 oz)
Total volume: 270 cm^3 (16·5 in^3)
Overall length: 190 mm (7·5 in)
Overall width: 76 mm (3·0 in)
Overall depth: 38 mm (1·5 in)
Length of case: 100 mm (4·0 in)

Operating range
The Hitefinder can be adjusted by the user to effect deployment of a parachute above any DZ situated between 213 m (700 ft) below sea level and 4270 m (14 000 ft) above sea level (ICAN Standard Atmosphere conditions prevailing)

Time delay
A choice of fixed time delay periods of from 0·30 to 6·00 sec is available. If required, instruments can be re-calibrated to alternative settings by the manufacturer.

Limits of accuracy
Every Hitefinder is extensively tested under laboratory conditions to ensure that each instrument gives a standard of accuracy within the following range:
Repeatability: ±15 m (50 ft)
0°C to +30°C: ±45 m (150 ft)
–10°C to +40°C: ±60 m (200 ft)
–30°C to +70°C: ±90 m (300 ft)
5 *g* acceleration in any altitude: ±60 m (200 ft)
15 *g* acceleration in any altitude: ±90 m (300 ft)

Due to the indeterminate position of the true static pressure head of a falling body and differences in theoretical and actual atmospheric pressure values these limits are liable to some variation. However, over 150 kinetheodolite monitored descents have shown the variations to be small and well within the limits of absolute safety.

IRVING AIR CHUTE OF GB LIMITED
Letchworth, Hertfordshire, England
Telephone: 6262 Cables: Irvin Letchworth Telex: 82198

Special aircraft equipment

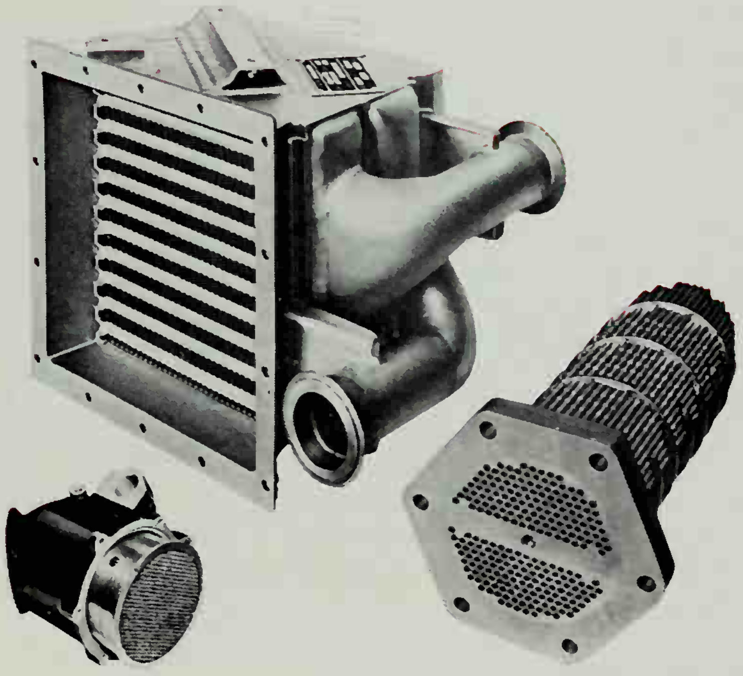
heat exchangers, flexible tanks, radomes

Heat exchangers

Marston Excelsior Limited is Europe's leading supplier of heat exchangers for all aircraft applications. The company has designed and manufactured units for almost all British-built aircraft for many years as well as for aircraft built in other countries. Heat exchangers in current production include units for the Hawker Siddeley Harrier and Nimrod, McDonnell Phantom and the BAC/Breguet Jaguar.

Applications for which heat exchangers have been supplied include units for air-cooled and fuel-cooled engine oil coolers, air/fuel heaters, air/air and air/water steam heat exchangers for cabin air conditioning, air/air units for pilots' ventilated suits, oil/air and oil/fuel coolers for hydraulic services, gearbox oil coolers, evaporators and condensers for refrigeration packs, as well as air/air—air/water glycol and air/oil heat exchangers for the temperature control of airborne radar and electronic equipment.

Units are made from aluminium alloys, stainless steel and nickel alloys, and are of both tubular and secondary surface brazed construction.



Flexible tanks

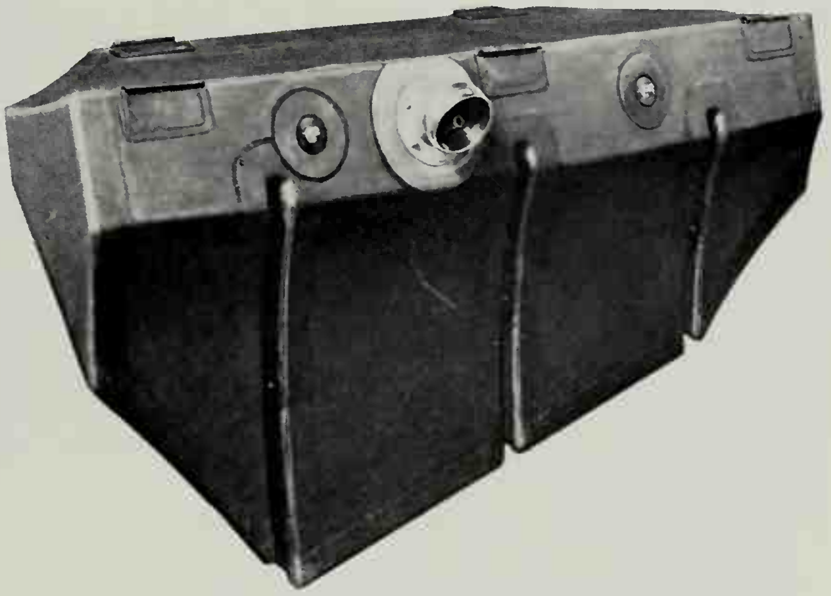
Marston Excelsior manufactures flexible tanks from a variety of specially developed materials for particular applications in aircraft and missiles, including tanks for hydrocarbon fuels, methanol/water and high-test peroxide (HTP), drinking water and waste water.

Materials include nitrile compounds for fuel and oils, Viton elastomer for HTP and for hydrocarbon fuels at high temperatures, and butyl and natural rubber for water. All materials are reinforced with terylene fabrics and in some cases special fuel barrier layers are incorporated within the composite material.

Operating temperatures range from −40°C to +200°C.

Self-sealing systems effective against small arms fire up to ½ in (12·77 mm) calibre can be incorporated.

Tanks are made to British and American MIL specifications.



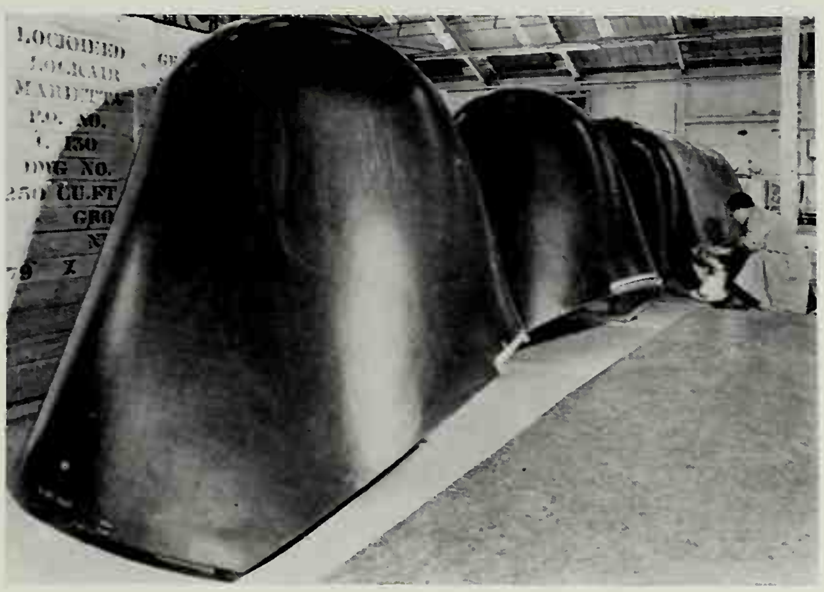
Radomes, aerial covers, aerial reflectors

Marston produces a variety of aircraft components associated with airborne radar equipment. Made from reinforced plastics materials, these include radomes, aerial covers and windows, and aerial reflectors.

In most cases the material used consists of woven glass fibre impregnated with polyester or epoxy resins moulded into a shaped laminate or sandwich of high strength/weight ratio with outstanding dielectric properties. Sandwich cores of glass or aluminium honeycomb or foamed materials can be incorporated.

When required radomes are built which incorporate a de-icing system.

Marston Excelsior Limited carries full approval of the British Ministry of Defence for the design, production, inspection and testing of heat exchangers, flexible tanks and radomes.



A subsidiary of Imperial Metal Industries Ltd

MARSTON EXCELSIOR LIMITED

Wobaston Road, Fordhouses, Wolverhampton, Staffordshire,
WV10 6QJ, England
Telephone: Fordhouses 3361 Cables: Marex Wolverhampton Telex Telex: 33211

Marston

Flight instruments

for all types of aircraft

Artificial horizon and horizon gyro

The Ferranti artificial horizon Type FH.14 and horizon gyro Type FH.15 are self-contained, electrically operated vertical gyros operating from a 115V, 400Hz, single-phase or 3-phase supply.

The artificial horizon FH.14 provides information of the movements of an aircraft, in pitch and roll, by means of a spherical presentation. The horizon gyro FH.15, which is otherwise identical with the FH.14, differs only in that, in addition, it is equipped with toroidal potentiometers on the pitch and roll axes.

Aircraft attitude is displayed by the position of a two-colour spherically shaped drum relative to a fixed symbol in the centre of the instrument glass. The division of the colours—blue sky/black ground—extending across the face of the instrument represents the true horizon. The drum carries a perspective display in the 'ground area' in one design, the length of the pitch reference lines increasing with pitch angle. Thus, at extreme pitch attitudes, when the horizon reference line may be out of sight, the pitch reference lines define the roll plane. A roll indicator is incorporated in either the top or bottom half of the presentation.

Electrical means are used to erect, and maintain erect, the gyroscope to the vertical. The pitch-bank system of monitoring during turns is incorporated. Arrangements are also made whereby the operation of an external push switch increases the erection rate to approximately 30 times its normal value. Operation of this switch in unaccelerated flight erects the gyro rapidly to the vertical position from any attitude.

The instruments are fitted with a combined power failure/gimbal centring device, and have provision for integral lighting.

Specification:

Life: unrestricted

Altitude: up to 18 300m (60 000ft)

Temperature range: –35°C to +55°C (no derangement between –40°C and +70°C)

Vibration: withstands vibration conditions detailed in BS.2G.100, Part 2. Clause 2.6, Grade C2, and Clause 218, Table 2, Grade C2, under anti-vibration mounted conditions (rigid mounting conditions to be declared)

Climatic: functions satisfactorily in conditions of repeated variations of air pressure, temperature and humidity and resistance to fungus growth as specified in BS.2G.100, Part 2, Clause 208, Climatic Class 1, with functioning test B carried out at –40°C

Radio interference: meets the requirements of BS.2G.100, Part 2, Clause 225

Compass interference: compass safe distance to be measured as defined in BS.2G.100, Part 2, Clause 227, and declared

Rigidity of fixing: capable of withstanding (without breaking loose) an acceleration of 25g applied in the fore-and-aft direction

Acceleration: the instruments satisfy the requirements of BS.2G.100 Part 2 Clause 219a, Table 3, Class 2B(ii). Grade C and Clause 219B, Table 4, Acceleration Class II for crash-landing

Interchangeability: complete instruments are mechanically and functionally interchangeable

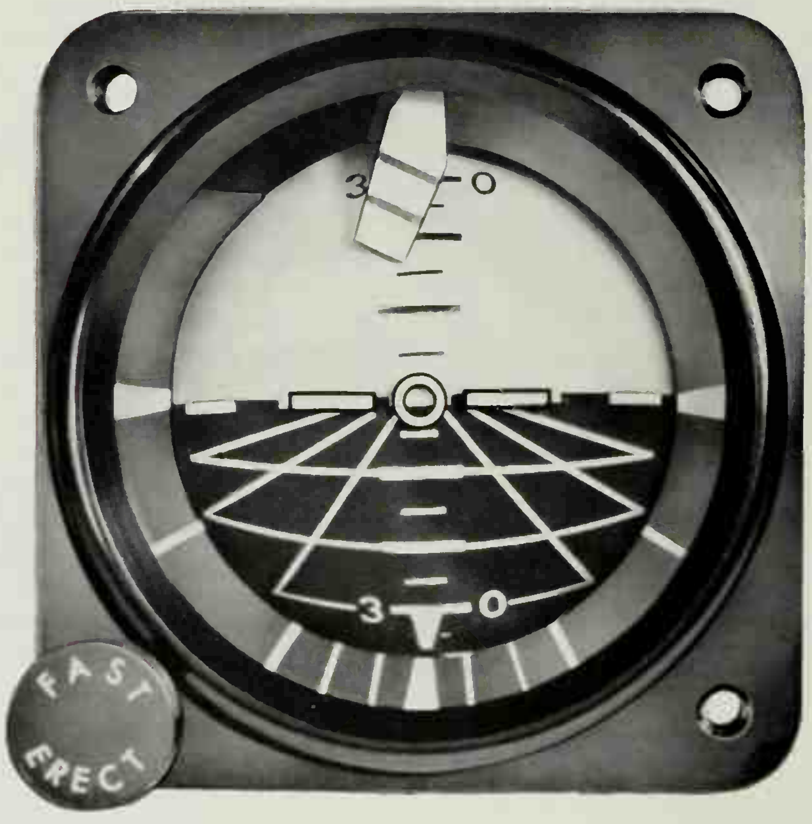
Electrical connections: via a 12-pin connector attached to a cable to suit customer requirements

Electrical supplies: (a) 115V ±5%V, 400Hz +5%Hz single-phase or 3-phase for the gyro wheel
(b) 28V dc (nominal) or 30V, 400Hz single-phase (max) for the potentiometers, the voltage limits being in accordance with BS.2G.100, Part 3
(c) 2·7V ac for lighting (when required)

Power consumption: starting cycle 40W (max); normal conditions 14W (max); fast erection conditions 35W (max)

Overall dimensions: 266mm (8·8in) long × 101mm (3·97in) across diagonals (3in ARINC case)

Weight: 2·27kg (5lb) maximum



The Ferranti FH.14 artificial horizon is a self-contained electrically operated vertical gyro

Single-axis accelerometer

The Ferranti single-axis accelerometer Type FA.2 Series is a force-feedback torque-restrained pendulous device capable of sensing a wide range of acceleration with extreme accuracy. Additional units in this series are manufactured to provide a lower restoring-coil impedance for operation with microcircuit amplifiers.

Specification:

Overall dimensions: 508mm (2in) × 254mm (1in) dia
Weight: 72g (2½oz)
Restoring-coil impedance: 207Ω ±5%
Pick-off excitation: 4V, 20kHz
Pick-off null voltage: 1mV (max)
Pick-off phase shift: 50° ±5° lead
Pick-off scale factor: 2·4mV/min/V
Range of measurement: ±20g
Scale factor: 5mA/g
Scale factor temperature effect: 0·005%/°C (max)
Bias: 3×10^{-4}g (max)
Bias temperature effect: $0{\cdot}02 \times 10^{-4}$g/°C (max)

SINGLE AXIS
ACCELEROMETER
TYPE FA2-F
SERIAL NO.
FERRANTI LTD.
MANCHESTER
ENGLAND

Ferranti single-axis accelermometer Type FA.2 is capable of sensing a wide range of acceleration with extreme accuracy

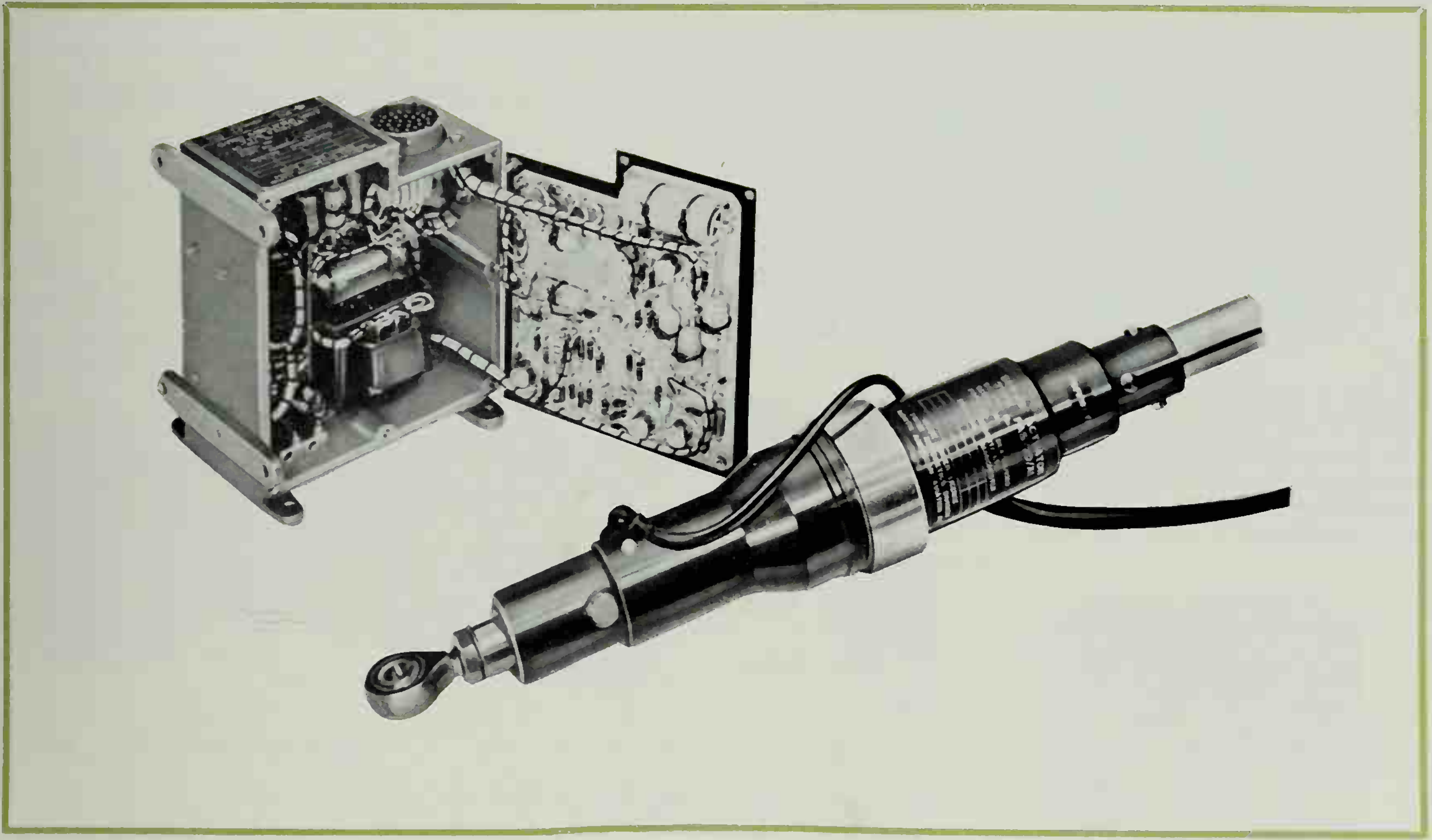
Autostabiliser

for helicopters

The Ferranti helicopter autostabiliser Type FAS.2 can be used in any or all control axes—yaw, pitch or roll—to provide a helicopter with a 'hands-off' operational capability even while hovering. The self-contained system comprises an amplifier and an extensible link servo actuator for each axis that requires stabilisation.

A rate gyro senses the deviations of the helicopter from its instantaneous attitude. The rate gyro signal is processed by a small computer which produces a servo actuator output to apply corrective control action. Servo actuator position and velocity are fed back and summed with the gyro signal to close and stabilise the control loop.

The actuator is positioned between the pilot's control column or pedal and the controlled aerodynamic surface or rotor. This arrangement allows the applied control deflections to be limited to those required for stabilisation, normally 10 to 20% of the maximum displacement, and no restriction on the manoeuvring of the helicopter is involved. Thus the natural 'feel' or response of the helicopter, as far as the pilot is concerned, is not materially affected but the operational capabilities of the helicopter are increased and the instrument flight capabilities are enhanced. Arrangements can be included in the autostabiliser for the necessary coupling between roll and yaw channels to produce co-ordinated turns during manoeuvres and, if required, the autostabiliser can be used as an autopilot with simple hold facilities for heading, height or speed.



Ferranti helicopter autostabiliser Type FAS.2 can be used in any or all control axes providing a complete 'hands-off' capability even while hovering

Weight and dimensions

Weight: single-axis installation 1·4–1·8kg (3–4lb); three-axes system 4·1–5·4kg (9–12lb) (depending on servo size)

Size: gyro amplifier unit (single axis) 102mm × 102mm × 51mm. (4in × 4in × 2in); servo—to suit installation

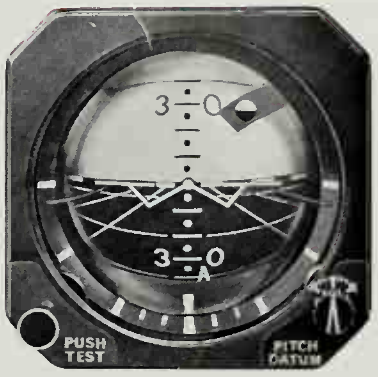
Additional weight for autopilot as little as 2·3kg (5lb)

FERRANTI LIMITED
Aircraft Equipment Department
South Hill Park, East Hampstead, Bracknell, Berkshire, England
Telephone: Bracknell 4202 Telex: 84117

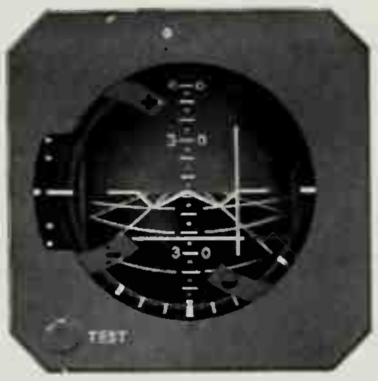
FERRANTI

Flight instruments

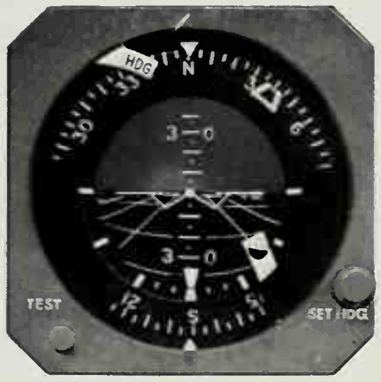
for civil and military aircraft



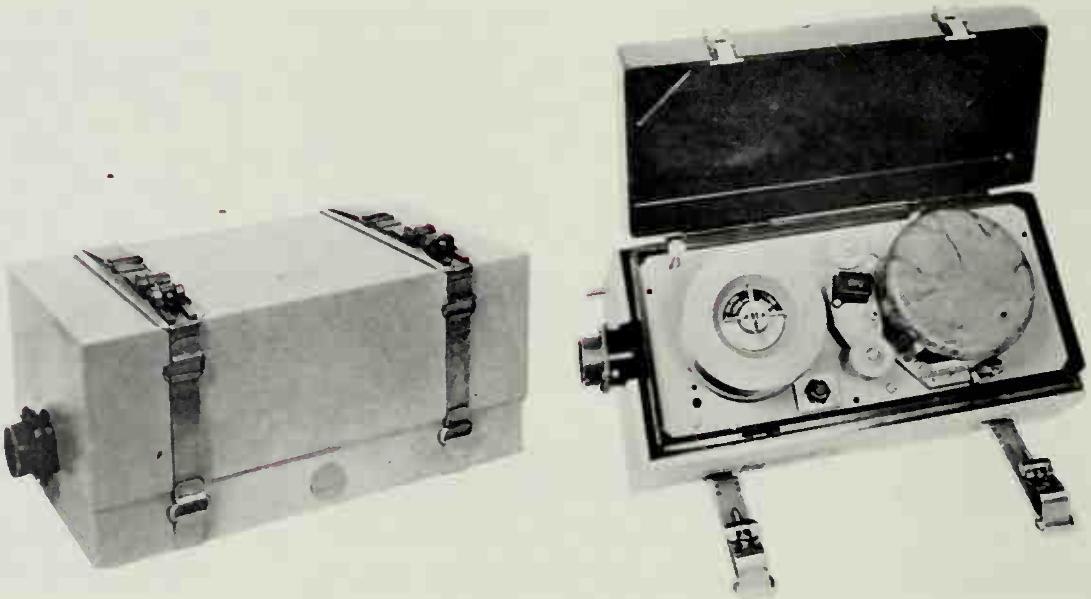
RAI 3 is an 83mm (3·270in) remote attitude repeater with integral servo amplifiers offering 360deg of freedom in roll and pitch.



AD 4 is a 100mm (4in) attitude director similar to the RAI 3 in presentation, but with conventional cross-pointer director wires superimposed on the instrument face. Presentation of flight-path vector information or airspeed error is also available.



HAI 4 is a 100mm (4in) heading and attitude indicator with integral servo amplifiers, showing conventional pitch and roll information with compass heading. A heading select facility for autopilot operation is included.

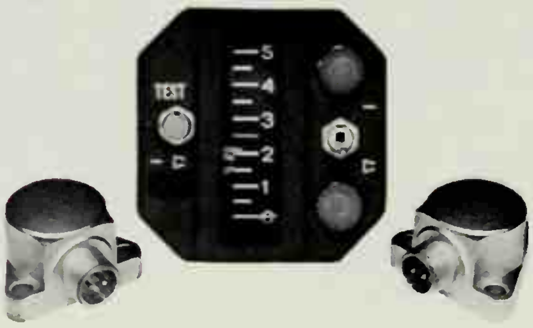


Sperry 6000 Series airborne data acquisition system

This system is particularly suitable for accident and flight profile/mission recording in military aircraft. It includes a digital wire recorder.

The utilisation of solid-state micrologic techniques enables the measurement and code conversion circuits to be accommodated within the recorder case.

Weight: 7·5kg (16lb 12oz)
Dimensions: 16 × 34 × 17cm (6·2 × 13·1 × 6·7in)
Duration of recording: 15 or 30h
Power requirements: 115V 400Hz 12W
Accuracy: ±0·5% of full scale
Resolution: 1 in 256
Capacity: 46 channels
Sampling rate: 46 channels/sec
Protection: to the survival requirements of accident recorders in military aircraft
Playback is available in one of the following forms: binary trace; analogue trace; decimal display; punched paper tape



STEVI

STEVI (Sperry Turbine Engine Vibration Indicator) is a 51 mm (2 in) panel-mounted instrument which provides early warning of excessive engine vibration from engine-mounted vibration pick-ups. High frequency is indicated continuously, low frequency is shown when the low filter button is pressed. An auxiliary unit can be used to monitor the low filter separately and continuously.

A variant of STEVI (illustrated) uses a solid-state piezo-electric accelerometer as the basic engine transducer. Outputs for recording are provided.

SPERRY FLIGHT SYSTEMS DIVISION
Sperry Rand Limited
Downshire Way, Bracknell, Berkshire, RG12 1QL, England
Telephone: Bracknell 3222 Cables: Speriflite Bracknell Telex: 84129

SPERRY

Gyro instruments

for military and civil navigation

SGP-500 Series platform

The Sperry SGP-500 is a small, low-cost, lightweight, Rotorace twin gyro system consisting of a gyro reference unit (GRU), an electronic unit (EU) and control panel, providing highly accurate and reliable outputs of heading and local vertical. It is based on the design and manufacturing techniques embodied in the development and production of a family of platforms (TGP) for aircraft that include Lightning Mks 3, 5 and 6, Mirage 111-0 and 4A, Buccaneer 2S Mk 50 and Mk 2, and Vulcan B2.

TGL-100 transfer gyro

The TGL-100 transfer gyro system is a new portable lightweight instrument designed to align rapidly and accurately aircraft heading references to a known heading before aircraft take-off. The instrument is equally suitable for both land- and carrier-based aircraft. The time required for aligning each aircraft system is 15 sec, while the azimuth accuracy is better than 0·1 deg rms. Transfer gyros have been sold to the air forces of France, Germany, Australia, South Africa and Italy.

Compass systems

Sperry manufactures a complete range of compass systems for conventional and rotary-winged aircraft, including:

CL11 a high-performance system giving a free drift rate of better than 1 degree per hour.
Variants of this system are fitted to a wide range of military and civil aircraft including the Hawker Siddeley Nimrod, Hawker Siddeley Dominie, Fiat G91 and Westland Wessex, Sea King, and WG13 helicopters.

C2G a lightweight standby system currently used in the Lockheed F104G and Hawker Siddeley Harrier aircraft.

C2J Similar to the C2G but having multiple heading outputs, the C2J comprises a magnetic detector, a compass controller and a gyro amplifier master unit (shown below). This system is specifically designed for use in high-performance aircraft, and is specified for the British versions of the Jaguar.

VGL-200 vertical gyro

The Sperry vertical gyro VGL-200 is a compact lightweight unit providing an accurate vertical reference, using synchros to transmit pitch and roll attitude information. A liquid-level/torque motor erection system is employed and provision is made for initial fast erection to eliminate the need for a mechanical caging system.

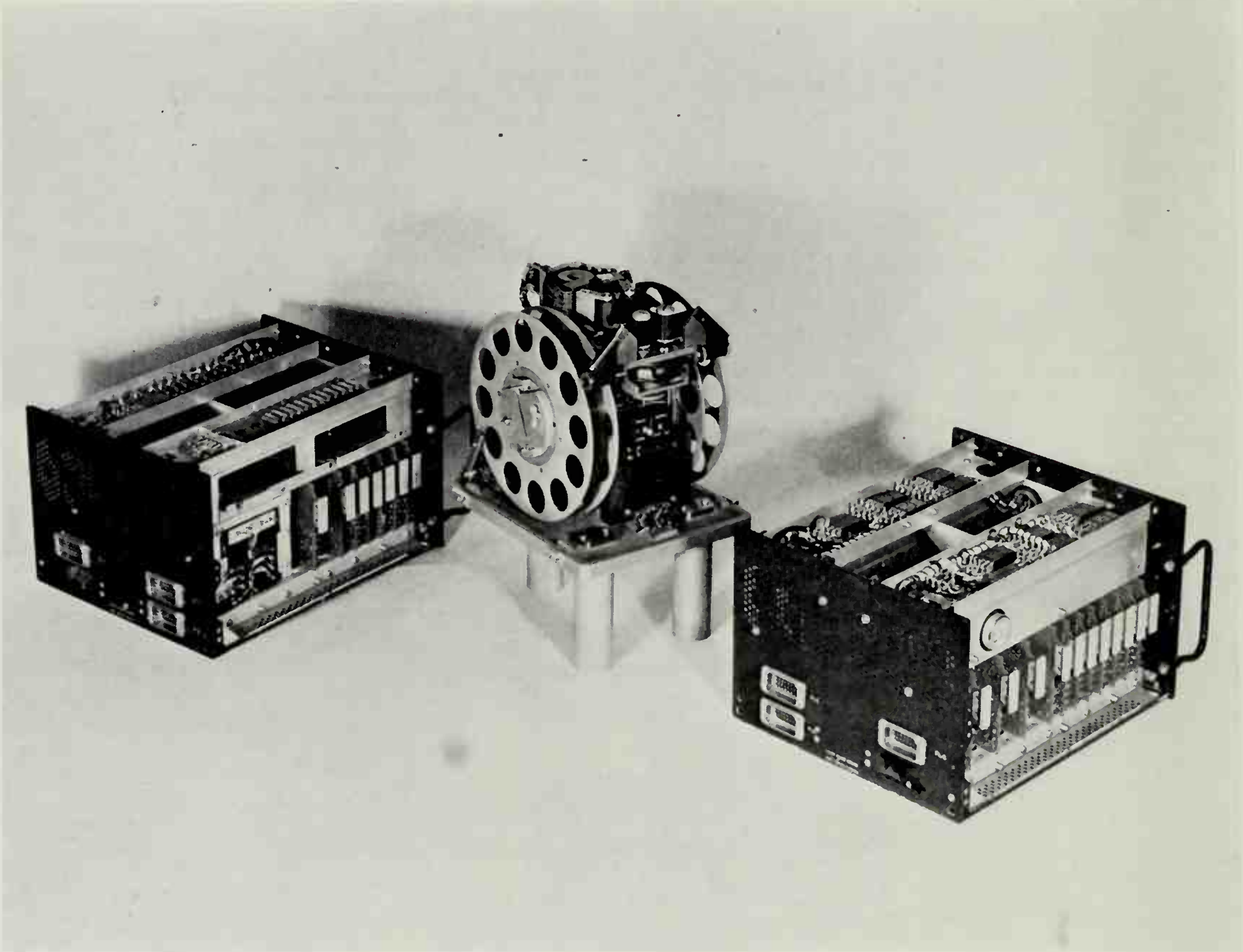
The gyro element has freedom in pitch of ±85 deg and full freedom in roll. It has a free drift rate (with the erection system cut off) of less than 15 deg/h. The erection rate is approximately 2·25 deg/min and the gyro element settles to define the gravity vertical to within 0·25 deg.

SPERRY FLIGHT SYSTEMS DIVISION
Sperry Rand Limited
Downshire Way, Bracknell, Berkshire, RG12 1QL, England
Telephone: Bracknell 3222   Cables: Speriflite Bracknell   Telex: 84129

SPERRY

In-flight data recorder

for mission analysis and other data acquisition



The M15 in-flight magnetic tape data recorder (centre) with input modules (left and right). The recorder uses standard computer tape, the tape reels being cheek-mounted for compactness. Construction is ruggedised to render the unit suitable for use as a crash recorder

Mission analysis

Marconi Space and Defence Systems Limited has unique experience in in-flight data acquisition and handling, being responsible for the Nimrod mission analysis recording and the prototype Concorde accident recording systems.

The M15 instrumentation recording system is the most sophisticated in-flight magnetic tape recording facility for mission analysis available today. It provides long duration operation and large data capacity in a small volume with the high accuracy and versatility of a laboratory recorder in a compact ruggedised form. The high standard of performance is maintained under extreme environmental conditions. Instrumentation recording systems for any of the following applications can be engineered: Mission analysis, airborne data acquisition, data format conversion, engine health monitoring, accident recording, ground replay and translation, and automatic data recording.

A GEC-Marconi Electronics Company
MARCONI SPACE AND DEFENCE SYSTEMS LTD
Instrumentation Group
Chobham Road, Frimley, Camberley, Surrey, England.
Telephone: Camberley 63311 Cables: Elliotauto Camberley Telex: 85289

Aeronautical charts

and flight data services

The specialist staff of International Aeradio Ltd has met the chart and flight data requirements of all types of air operations for more years than any other organisation in the world.
The high quality and accuracy of its products derives from many years of practical experience and from continuous close contact with operating personnel in all branches of aviation both civil and military in the UK and abroad.
The service is unique, being not merely the initial provision of flight documentation but its regular systematic up-dating. The first annual subscription includes the initial supply of complete flight documentation for the territory defined by the subscriber, and thereafter all revised and reprinted charts and flight data are posted weekly.
The detail appearing on International Aeradio charts is shown on the reverse side of this sheet. Supplementary publications give navigational aid and communications listings, air traffic control regulations and much other data necessary for flight planning and in-flight reference. Part of a specimen page from a supplement is reproduced below.
For the last four years the company has been actively engaged in the production of another series of maps for microfilming in connection with a moving-map display for installation in the new generation of aircraft now being manufactured and delivered., The company leads the world in this new method of displaying to aircrews the information they currently obtain from paper maps and charts. Operators who are contemplating using this advanced equipment should write to the Company's Aerad Flight Documentation and Printing Division for details.
For many years the company has also printed other specialised air navigation charts and undertakes all kinds of printing for the aviation industry.

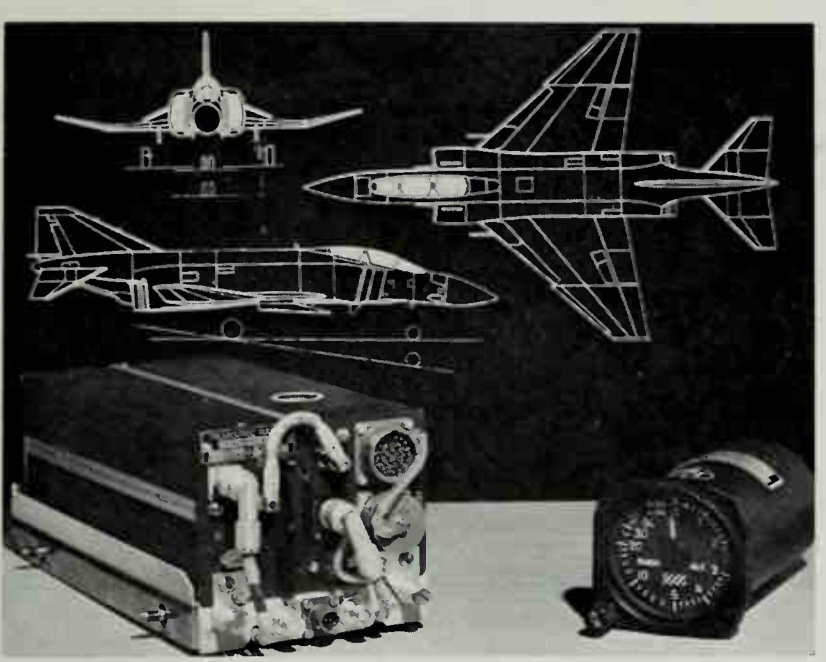
INTERNATIONAL AERADIO LTD
Aerad Flight Documentation & Printing Division
Hayes Road, Southall, Middlesex, England
Telephone: 01-574 2411 Cables: Aerad Southall Telex: 24114

IAL

Name, Location Indicator and Co-ordinates				Fac.	Ident. or Callsign	Freq. NDB Emis./Pwr. or Rng & Met. Information			R
Milan (Linate)	LIMM	… …	… …	MET	Milan Volmet	126·6	Ae t	*H24 Cont.*	*Malpensa, Linate, Turi* *Ciampino, Geneva, Zuri*
					Zurich Met	127·2	Ae t	*H24*	… *Cont.*
					Geneva Met	126·8	Ae t	*H24*	… *Cont.*
					Rome	126·0	Ae t	*H24*	… *Cont.*
					Innsbruck	127·0	Ae F	*H24*	… *Cont.*
					Shannon Aeradio	5559 8828·5 3001[1] 13272[2]		*H24* [1]*22–10*, [2]*10–22*	} *H+10(Ae F), H+*
				APP	Milan Arrivals/D'tor	118·8		*H24.*	
				TWR	Linate Twr	118·1 123·5[1] 121·5E[1]		*H24*	… [1]*O/R.*
					Linate Ground	121·8		*H24.*	
		4526N	0917E	VDF	Linate Hmr	118·4 118·8[1] 121·5E[1]		*H24*	… [1]*O/R.*
		4521N	0917E	NDB	LIN	386	A1/25 nm	*H24*	… *5·37 nm to R/W 36.*
				ILS (36)	LIN	110·3/335·0 (2·75°)		*H24*	… *B.B. not usable.*
				OM	… … … … …	… … … … …		…	… *5·4 nm.*
				MM	… … … … …	… … … … …		…	… *0·55 nm.*
				GCA	Linate GCA	119·25 119·4 118·1 118·8 123·5 121·5E		*IMC & O/R 30 mins.* *IMC & O/R 30 mins.*	
				SRE	Linate SRE	123·1 121·5E			
Milan (Malpensa)	LIMC	… …	… …	MET	Zurich Met	127·2	Ae t	*H24*	… *Cont.*
					Rome	126·0	Ae t	*H24*	… *Cont.*
					Geneva Met	126·8	Ae t	*H24*	… *Cont.*
					Innsbruck	127·0	Ae F	*H24*	… *Cont.*

Landing aids

for airborne and ground use



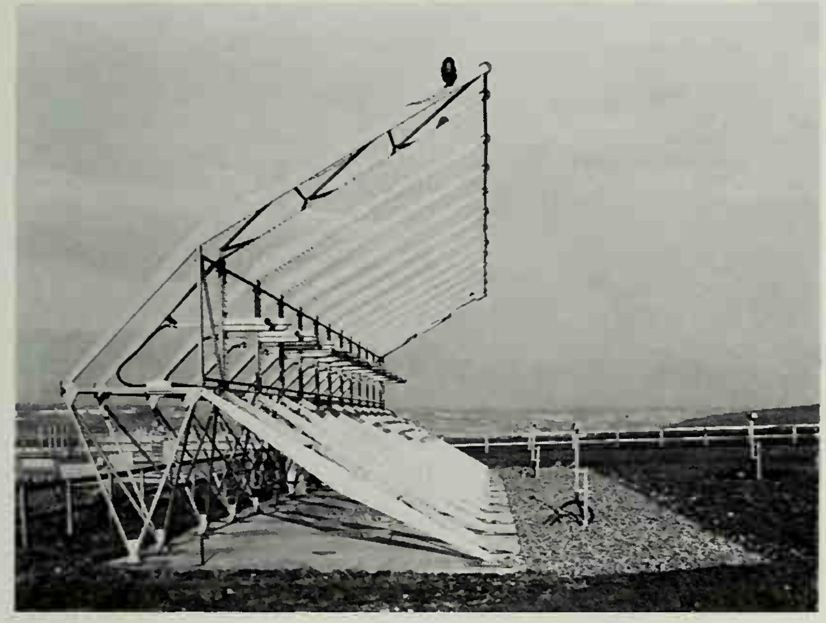
STR.70-P radio altimeter as supplied for Phantom aircraft

Radio altimeters

STC is a leader in the field of radio altimetry. Equipments have been supplied to the Blind Land Experimental Unit of the British Royal Aircraft Establishment for the all-weather landing programme and more recently for use in the BEA Trident and BOAC VC.10 autoland systems.

The STR.70-P/3, latest in the range of STC radio altimeters, is a microminiaturised equipment for use in all military roles including terrain following, automatic landing, low approach, helicopter autohover, low-level strike and many other flight control systems.

Technical data
Height range: 0–1520 m (0–5000 ft)
Accuracy: ±3% or ±1 m (3 ft) 0–150 m (0-500 ft); ±5% 150–1520 m (500–5000 ft)
Outputs: log/linear or to suit applications
Tracking rate of time constant: 100 ±25ms
Transmitter frequency: 4300 ±5 MHz
Power supply: 115 V ac ±5% 400 Hz ±5 Hz 55 VA nominal
Major specifications: AVP24; DEF5000; MIL-E-5272; MIL-1-6181; BS 2 G100 DEF 133

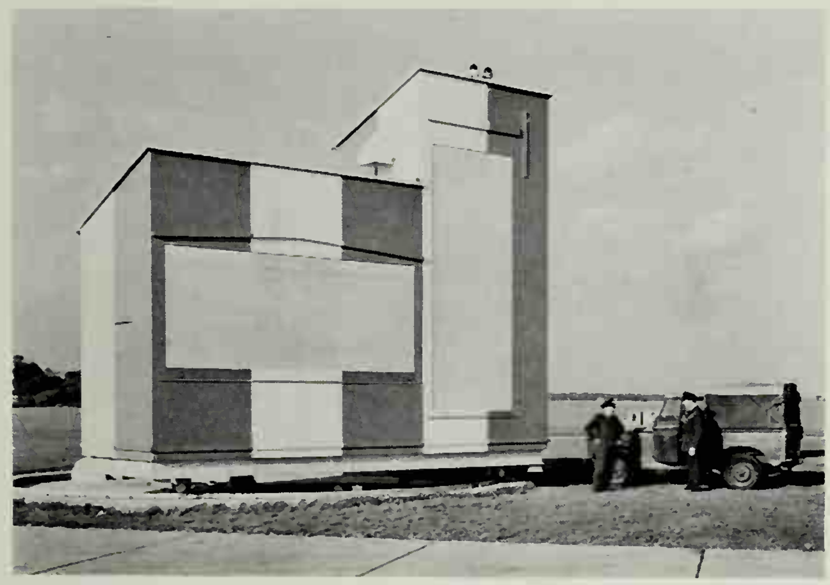


STAN.37 instrument landing system localiser aerial array

Instrument landing system

The STAN.37/38/39 is a fully solid-state instrument landing system designed to meet all ICAO facility performance categories. Lower category configurations can be upgraded to a higher category by the addition of standard units with minimum interruption of service.

Technical data
Meets full ICAO requirements
Fully dualised equipment
Various aerial configurations to meet site difficulties
Fully transistorised
Available in pan-climatic containers



SLA.3-C precision approach radar runway turntable building

Precision approach radar

The SLA.3-C is the latest STC precision approach radar equipment providing clear and unambiguous information to enable the final approach of high-speed jet aircraft to be monitored.

It embodies many new features and refinements resulting in an equipment whose performance surpasses the parameters laid down by ICAO.

Technical data
Fully dualised equipment
Pan-climatic operation
Turntable building to serve different runway approaches
Range 30 km (14 nm) for small jet aircraft head-on

An associate of ITT
STANDARD TELEPHONES & CABLES LTD
Radio Products Group
Oakleigh Road, New Southgate, London N11, England
Telephone: 01-368 1200 Telex: 261912

STC

Rubber components for aircraft

Avon specialises in the design and development of rubber products for aircraft and produces moulded components and rubber-to-metal bondings for a variety of aircraft applications.

Avon also manufactures specialised parts in sophisticated polymers and polyurethane.

Among the products made are engine transit mountings, aircraft hose and polyurethane anti-erosion sheeting, as well as many special-purpose products.

Avon Rubber Co Ltd
Bradford-on-Avon, Wiltshire, England

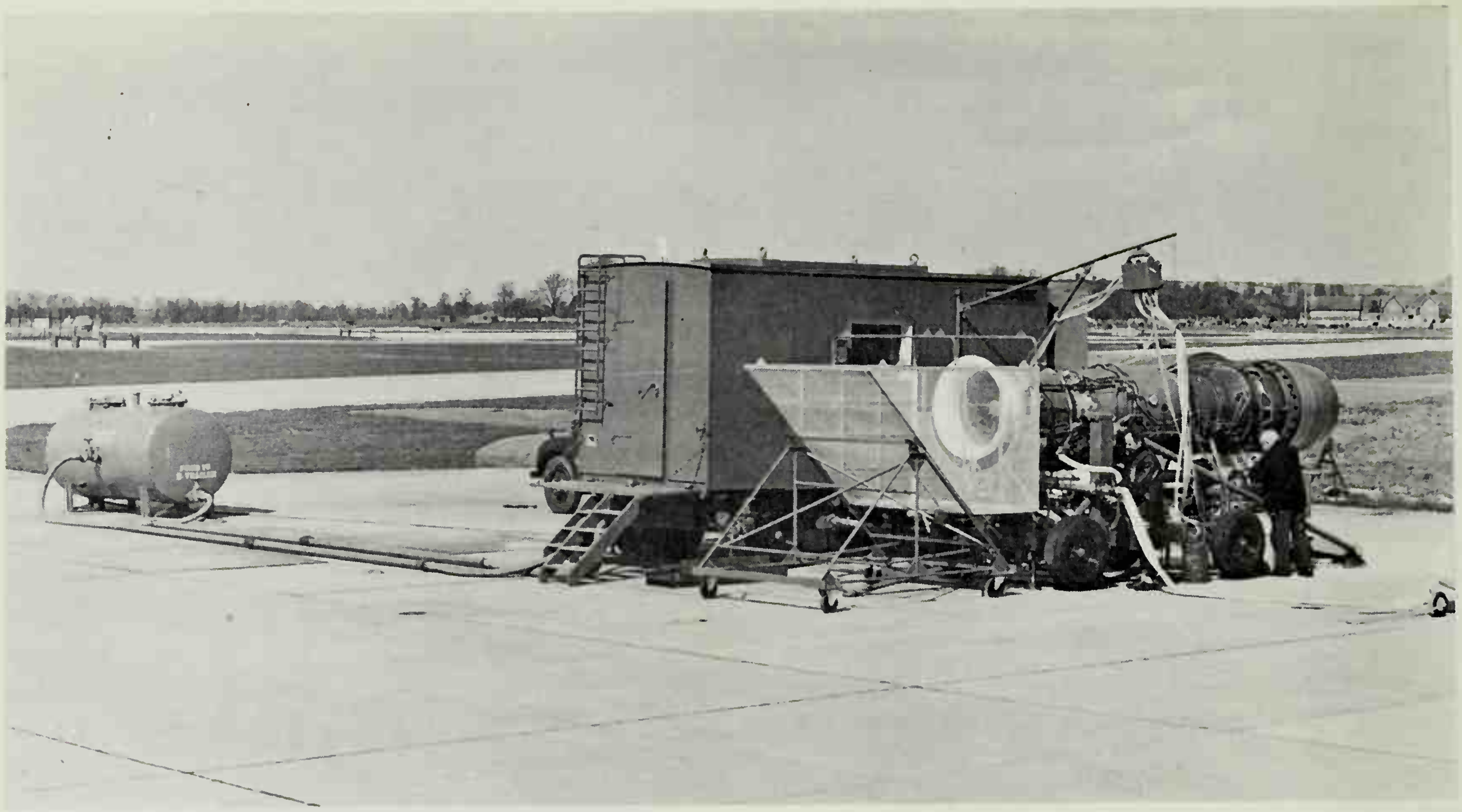
Telephone: Bradford-on-Avon 2191

Cables: Industrial Bradford-on-Avon

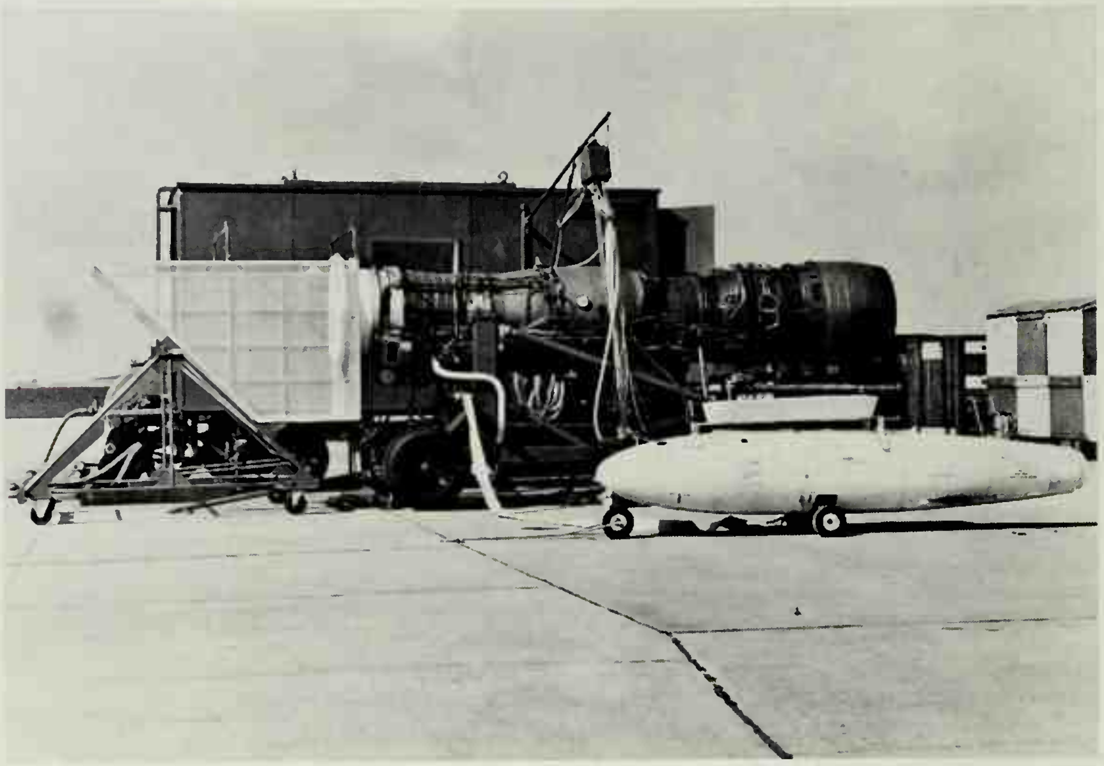
Telex: 44856

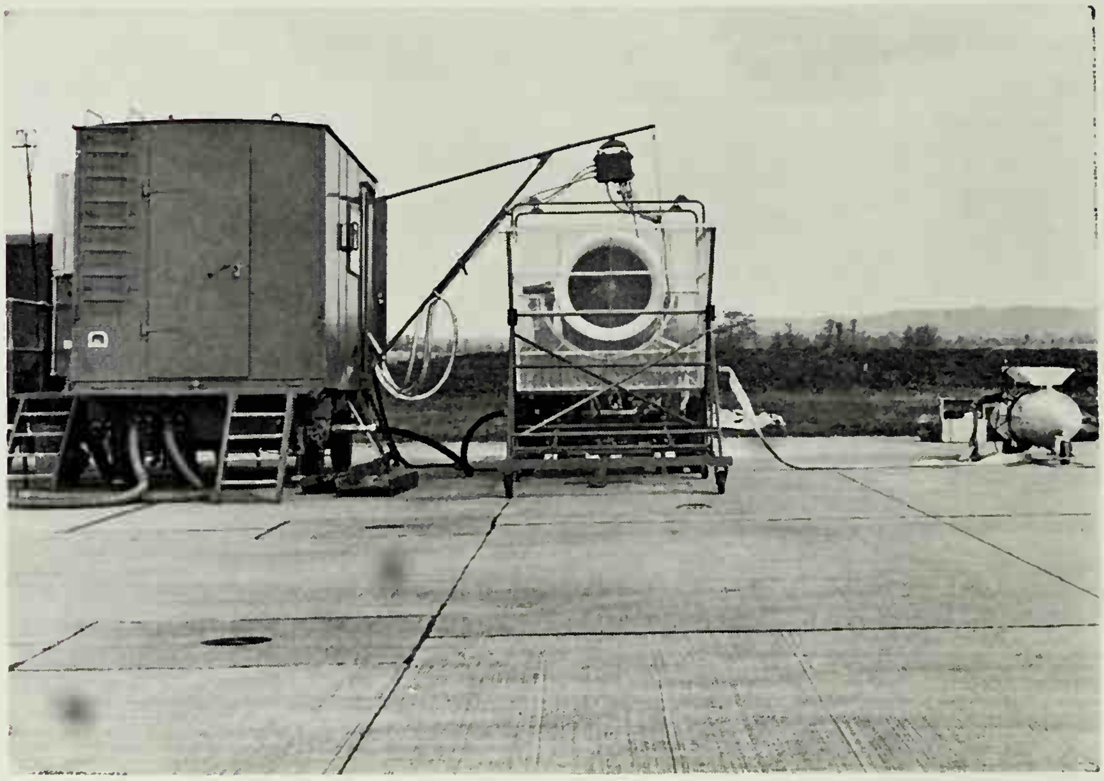
Section 21

Airfield equipment and services



Curran mobile engine run-up stand with a Rolls-Royce Spey engine mounted on it. Stands can be supplied to suit any engine and tailored to meet exact customer needs. After being brought into service they remain readily adaptable to cater for changing engine requirements in the future. A complete installation comprises services trailer, propulsion unit test stand, hold-back frame, engine adaptor sets, intake guard, fuel tank and inter-connecting services





The stand requires only a suitable hard-standing with ground ring bolts for anchoring the hold-back frame. Its mobility enables it to be moved easily from one location to another and set up quickly with minimum site preparation. Advice and guidance on associated de-tuning arrangements, where required, are available

Mobile engine run-up stand

for quick, economical check-running of turbo-jets

It is generally more expedient to remove a defective or suspect engine from an aircraft than to attempt to rectify it *in situ*. This usually means the costly return of the engine to the manufacturers or to an overhaul base, when often the fault proves to be of a minor nature, easily rectified.

The mobile engine run-up stand provides a simple and economical means of check-running such engines, enabling adjustments to be made and minor defects rectified quickly and efficiently. It reproduces as closely as possible the conditions under which the engine runs in the aircraft, with aircraft type instruments and controls and with provision for using standard aircraft test sets.

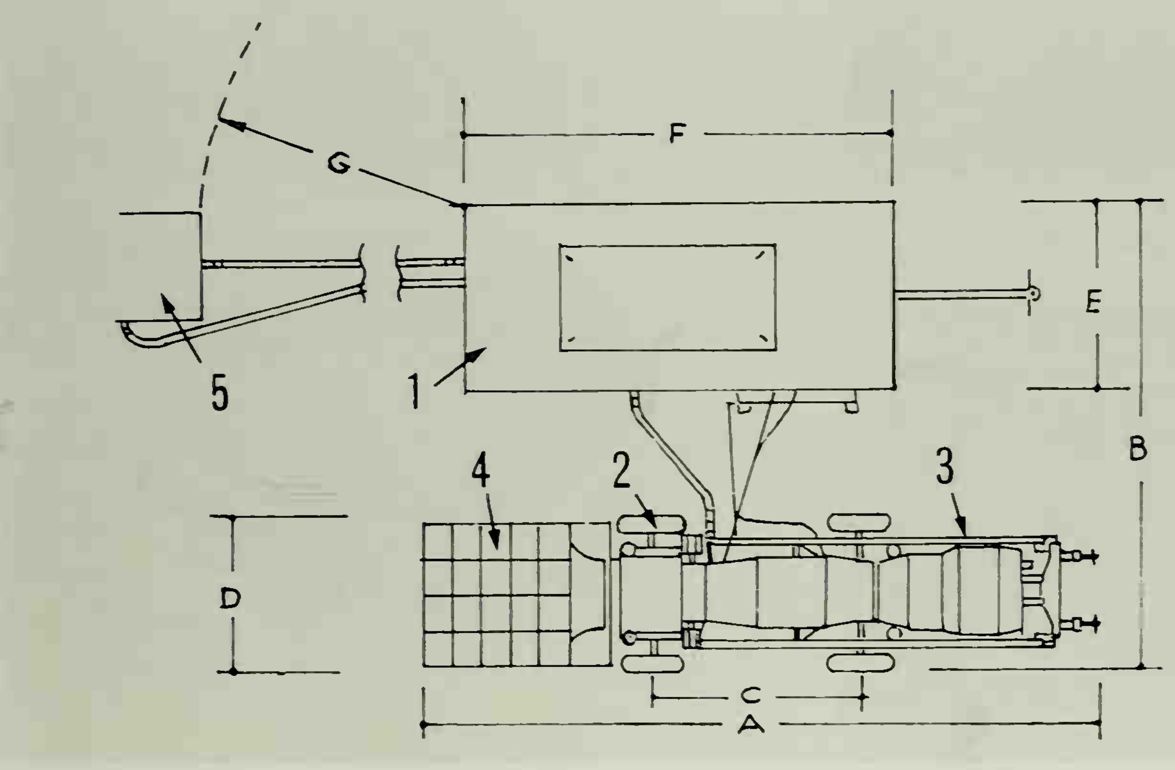
Mounting the engine on the propulsion unit test stand, complete with intake and exhaust systems, is easily and quickly achieved. As the stand is mobile this can be done at any convenient location (workshops, hangar, at the aircraft, etc). At the testing site, the stand is simply secured to the pre-anchored hold-back frame and all necessary interconnections rapidly made.

The engine is controlled from, and its performance registered in a control room in the sound-proofed and air-conditioned services trailer. The trailer also houses the main elements of the fuel, electrical and air systems. An observation window allows the engine to be viewed during testing.

Positioned in front of the engine, the intake guard protects it against ingesting foreign matter. The fuel tank shown holds 4550 litres (1000gal) and has an associated gauging system which registers its contents in the control room.

The services trailer and the propulsion unit test stand are each fitted with a sprung chassis on pneumatically tyred wheels. Parking and over-run brakes are incorporated. The fuel tank is free-standing and easily lifted and carried away. All other items are also readily transportable.

While the equipment does not feature thrust measuring capacity in its basic form, this can be included when required.

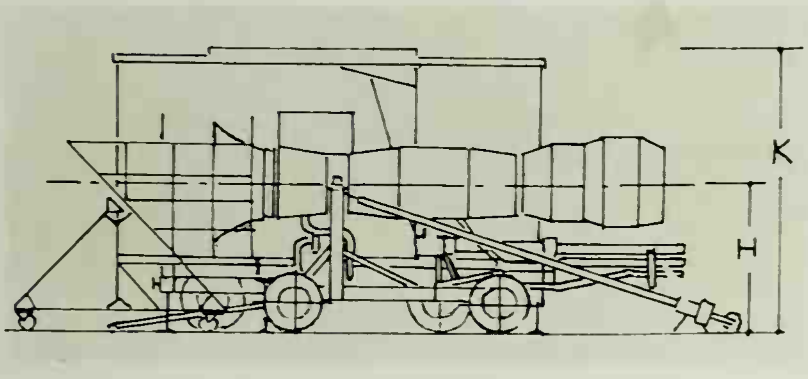


Key to main components

1—Services trailer
2—Propulsion unit test stand
3—Hold-back frame
4—Intake guard
5—Fuel tank

Principal dimensions

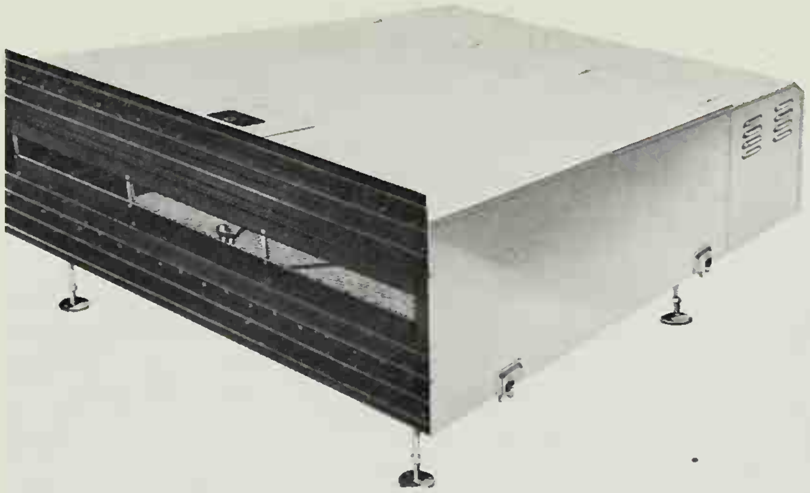
A—9·22m (30ft 3in)
B—5·94m (19ft 6in)
C—2·59m (8ft 6in)
D—1·98m (6ft 6in)
E—2·29m (7ft 6in)
F—5·34m (17ft 6in)
G—9·14m (30ft) radius
H—2·19m (6ft 2in)
K—3·57m (11ft 9in)



Aero-engine test equipment

The mobile engine run-up stand is one of a comprehensive series of facilities manufactured for testing all types of aero-engine from piston to the latest turbo-jet models. John Curran Ltd would be pleased to furnish further details. With years of experience, backed by a highly competent team of design, production and installation engineers, the firm is well placed to give expert advice and welcomes enquiries on any aspect of aero-engine testing, including test house layout and design of ancillary services.

JOHN CURRAN LIMITED
GPO Box 72, Curran Road, Cardiff, CF1 1TE, Wales
Telephone: Cardiff 20641 Cables: Narruc Cardiff



Visual approach slope indicator, with adjustable feet for accurate lining up

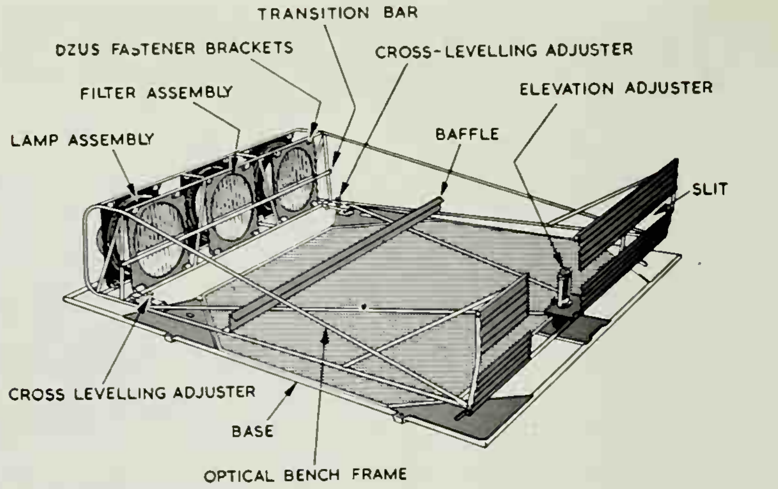
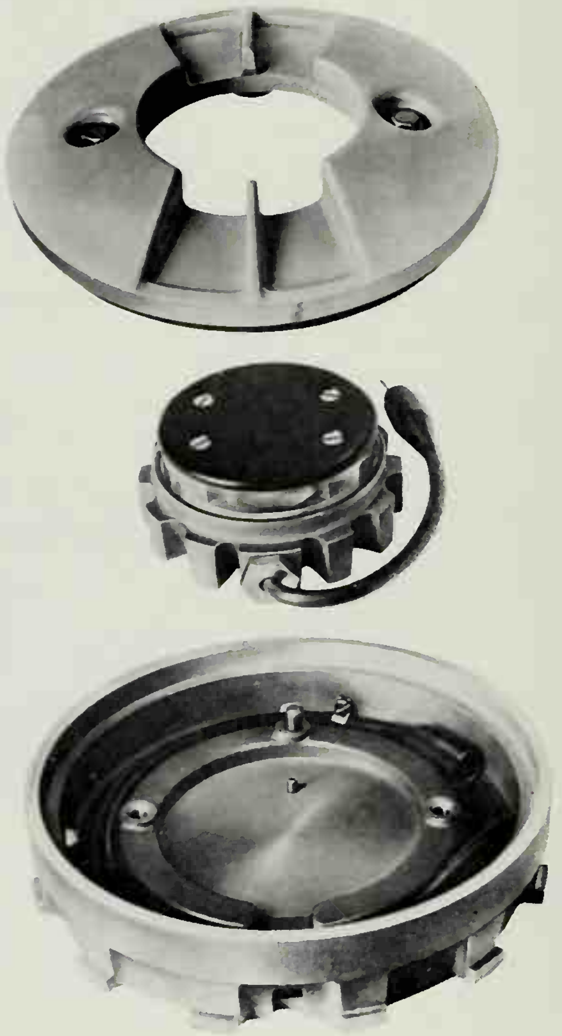
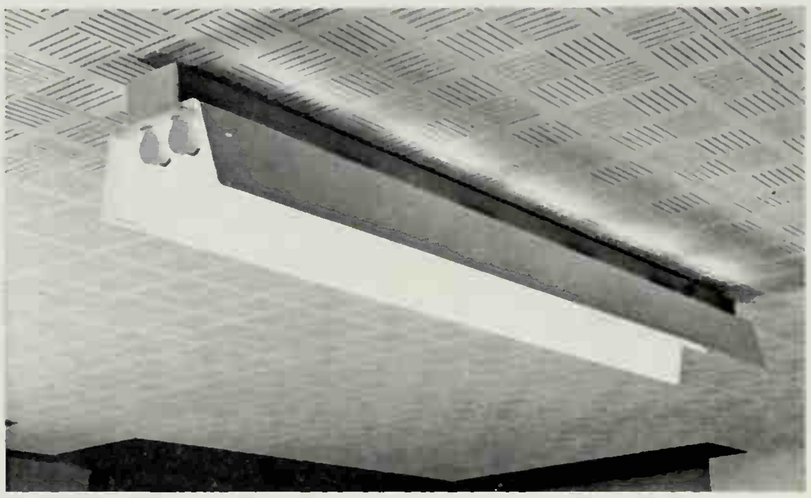

TRANSITION BAR
DZUS FASTENER BRACKETS
CROSS-LEVELLING ADJUSTER
FILTER ASSEMBLY
ELEVATION ADJUSTER
LAMP ASSEMBLY
BAFFLE
SLIT
CROSS LEVELLING ADJUSTER
BASE
OPTICAL BENCH FRAME

Diagram of visual approach slope indicator, showing internal design

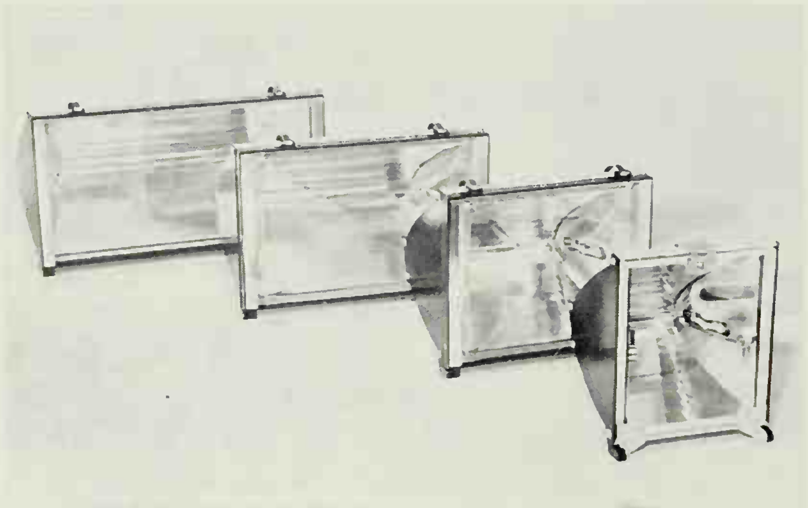
Typical Atlas flameproof fitting suitable for use in explosive atmospheres



Runway fitting, showing base, light unit and cover



Atlantic 3 fluorescent light fitting



Haline tungsten halogen floodlights, showing (left to right) 2000 W, 1500 W, 750/1000 W and 300 W units

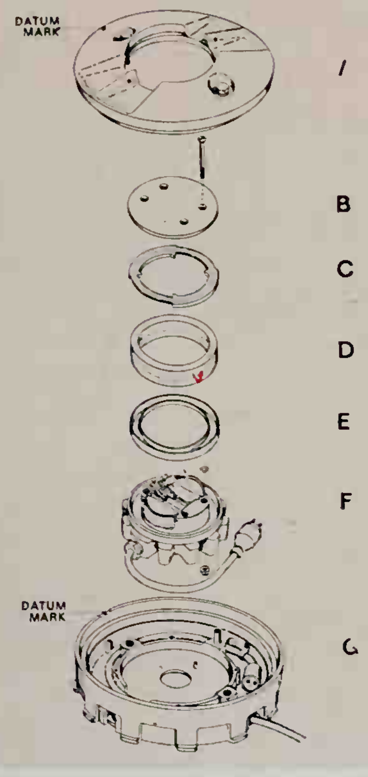
Sunflood 500 W tungsten halogen floodlight

Lighting equipment

for airfields, aprons and buildings

Thorn Lighting Limited manufactures a wide range of equipment suitable for all lighting purposes. Featured here is a selection of fittings designed for, or specially suitable for airfields and associated buildings and areas.

Exploded view of runway fitting; see also opposite page



Runway fittings

These fittings are designed to meet the ICAO requirements and consist of three die-castings in LM6 aluminium: base, light unit and cover. All screws, bolts, nuts, etc., are of stainless steel. The castings are anodised finished against corrosion. A 200 W 6·6 A tungsten-halogen lamp is used which has a 600-hour life at full intensity.

Dimensions:
Diameter 295 mm (11·614 in)
Depth below runway surface 64 mm (2·520 in)
Projection 17 mm (0·67 in)

The exploded view of the runway fitting at the left shows:

A	The cast steel cover with fixing bolts
B	Top plate for the lighting unit
C	Upper gasket
D	Ring window of heat-resistant glass
E	Lower gasket
F	Lighting unit, containing lamp lenses and plug-in lead
G	Main housing. The external castellations grip the runway surfacing compound and help to hold the housing firmly in position.

Visual approach slope indicator

The Thornray VASI is based in every principle on equipment designed and developed at the Royal Aircraft Establishment at Farnborough, England.

No of units: 12 in full set
No of lamps: 3 per unit, 36 in a full set
Lamp: 200 W, 30 V, 6·6 A or 12 V, 16·6 A; 1000 hours nominal life
Power: 7·2 kW max lamp load
Intensity: 60 000 candelas white, 15 000 candelas red sector
Brilliancy control: 3 stages 100%, 30% or to user requirements
Range: 7·2 km (4·5 miles) by day, 24 km (15 miles) or more by night
Angle of approach path: 2°–4½°
Depth of approach path: from 7·6 m (25 ft) to 15·2 m (50 ft) as required
Unit dimensions: 1·45 × 1·45 × 0·406 m (57 × 57 × 16 in)
Weight of unit: 46 kg (80 lb)
Finish: exterior aviation yellow; interior matt black
Temperature range: operates between −20°C and +50°C

Haline tungsten halogen floodlights

This family of floodlights—500/750/1000/1500/2000 W—is suitable for area lighting, buildings, precincts, stadia, vehicle parks, forecourts or any purpose where a wide horizontal beam spread and accurate vertical beam control are required.

The one-piece reflector/body unit of extruded aluminium gives rigidity and accuracy for best and most consistent optical performance. The end plates, back support, knuckle joint and cool wiring box are in die-cast LM6 aluminium alloy. The heat sinks are lever-operated and must be engaged before the fitting can be closed. Re-lamping access is via the hinged silicone rubber-gasketed front frame with toggle catches. These floodlights are available as 500/1500 W units at 110–240 V, or as 2000 W units at 240 V only. Various mounting accessories are available.

Sunflood 500 W tungsten halogen floodlight

This is a general-purpose open floodlight for outdoor area lighting.

The body is pressure die-cast in LM6-M aluminium alloy, measuring 203 × 165 × 102 mm (8 × 6½ × 4 in). The complete fitting weighs only 0·9 kg (2 lb). The lamp is a 500 W tungsten-halogen unit. A range of mounting spigots and brackets is available.

Flameproof fitting

In addition to being certified as suitable for use in all Division 1 areas having flammable atmospheres falling within the General Industrial Groups 2 and 3, this fitting is also dust-tight and rainproof. It may be used in areas containing explosive dusts or on oil-loading jetties and similar outdoor locations.

Atlantic 3 fluorescent fitting

The Atlantic 3 range of fluorescent fittings is not only elegant and efficient, but also most economical.

With its vitreous enamel reflector the Atlantic 3 batten, which is 1·8 m (6 ft) long, gives efficient service in hangars or stores with maximum economy owing to the 6-ft 85 W high-efficiency circuit used.

THORN LIGHTING LIMITED
Airfield Lighting Division
Thorn House, Upper Saint Martin's Lane, London, WC2H 9BR, England
Telephone: 01-836 2444 Cables: Eleclampo London WC2 Telex: 21521

THORN

1968
To Atlas Lighting Ltd

Landing mats and pads

for aircraft and helicopters

Aircraft landing mats (ALM)

The purpose of the ALM is to provide quickly a surface suitable for most medium passenger-carrying aircraft and most freight aricraft. It is not suitable for high-speed military aircraft. The effectiveness of the mat depends on the firmness of the ground under it.

When laying an aircraft landing mat (ALM), a laying rate of approximately 23·2 m² (250 ft²) per man-hour for completely unskilled labour can be maintained

Specification

Material: Lightweight extruded aluminium alloy BA25-TF conforming to British Standard 1476:HE 30-TF having a minimum tensile strength of 29·5 hbar (30·1 kg/mm²; 42 800 lb/in²).

Dimensions: The dimensions of an ALM depend on the type of aircraft using it and on the prevailing weather conditions. For a C130 aircraft in variable crosswinds a mat of 30·5 × 1220 m (100 ft × 4000 ft) would be required.

A C130 aircraft coming in to land on the ALM. A servicing area is visible in the foreground. Sand-bags provide side restraint

Aircraft forward operating pads (FOP)

The FOP provides a heat- and erosion-resistant surface for both jet VTOL aircraft and helicopters, where repeated take-offs and landings could destroy the ground surface. The effects of ground erosion from jet blasts or heavy down-draughts can cause dust and grit to be thrown up and sucked into the air intake with harmful results. FOP can also be used for short take-off/landing aircraft (STOL); for this purpose six pads are laid together.

Harrier aircraft on a forward operating pad (FOP) laid on top of a rubber membrane; the membrane is required in very wet or very dusty conditions

Specification

Material: As for the ALM.

Dimensions: A standard FOP consists of a nominal 15 × 15 m (50 × 50 ft) area of individual interlocking panels 2·75 m (9 ft) long × 0·25 m (9·8 in) wide. When used by STOL aircraft the six pads used form an area 91·5 × 15 m (300 × 50 ft).

The special aluminium alloy section used for the ALM and FOP was developed by the British Ministry of Defence in collaboration with The British Aluminium Company Limited which holds the sales rights

THE BRITISH ALUMINIUM COMPANY LTD
Norfolk House, St James's Square, London SW1, England
Telephone: 01-839 8888 Cables: Britalumin London SW1 Telex: 22756

Airfield membranes

for temporary runways and helicopter pads

Airfield membranes have been developed by Greengate & Irwell to protect ground which is strong enough to bear aircraft, helicopters and hovercraft. The membranes obviate the softening effect of rain and inhibit the formation of dust during helicopter and hovercraft operations. Strong enough to allow the use of stores-handling and service vehicles, the surface is lightweight and durable under all storage conditions. Each membrane comprises a 25·6 × 25·6 m (84 × 84 ft) square of nylon fabric coated on each side with Neoprene. A single sheet can be easily hand-laid by twenty men in twenty minutes.

Two grades of membrane are available: PSN 1 which is designed for helicopter and hovercraft pads and the taxiways, aprons and spin-up areas of runways, and PSN 3 which is used for the sections of runways subjected to braking. PSN 1 membrane has a perimeter flap which forms a soil-filled packet for ground anchorage during helicopter operations. PSN 3 can be coated with an anti-skid resin paint to allow safe operation under all weather conditions. Membranes can be supplied complete with anchor pins and adhesive for joining sheets and effecting field repairs.

Apart from ensuring safe operation under all weather conditions, the use of Greengate & Irwell membranes minimises dust damage to engines and camouflages the airstrip under dry conditions.

Specification

	Tensile strength	**Weight**
PSN 1	7·4 kg/mm (400 lb/in)	0·59 kg/m² (17·5 oz/yd²)
PSN 3	17·8 kg/mm (1000 lb/in)	1·09 kg/m² (32 oz/yd²)

A member of the Slater, Walker Group
GREENGATE & IRWELL RUBBER CO LTD
Coated Fabrics Division
Greengate, Manchester, Lancashire, M60 3EA, England
Telephone: 061-834 5652 Cables: Para Manchester 5 Telex: 66762

1969

Cloud base recorder system

for airfields or meteorological stations

This system, approved by the British Meteorological Office, consists of three units: a transmitter, a receiver, and a recorder, and is designed to record continuously on a chart the height of the cloud base. The system operates on the triangulation principle in which the transmitter scanner emits a modulated light beam. The receiver, vertically aligned and tuned to the light beam modulation frequency, feeds the cloud signal to a phase-sensing circuit in the recorder. The recorder contains a chart mechanism, in which the pen is deflected in synchronism with the transmitter scanner motion.

Transmitter

The transmitter unit contains a 406 mm (16 in) parabolic searchlight mirror producing a beam of 2° divergence, with a 200 W quartz iodine projector lamp as the light source. Under normal operating conditions the minimum lamp life is 800 hours. A revolving shutter disc, driven by a synchronous motor, is placed between the lamp and the mirror to modulate the light at a constant frequency of 900 Hz.

A photocell picks up from the mirror a 900 Hz reference signal which is amplified and fed to the recorder.

The searchlight assembly is pivoted so that the beam scans in elevation through an arc from 8° to 85° and back to 8°. The time taken for a complete cycle is one minute.

A magslip torque transmitter, driven from the searchlight shaft, communicates the angular position of the searchlight to a magslip torque receiver in the recorder.

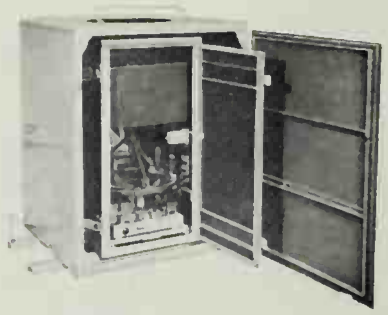
The transmitter unit is fully weatherproofed and air-conditioned

Receiver

The reflected cloud signal is detected by a photocell positioned at the focal point of a 406 mm (16 in) vertically directed parabolic mirror. The photocell output is fed to the input of the receiver signal amplifier, tuned to 900 Hz. The signal amplifier output is fed to the recorder unit.

Each time the searchlight beam reaches its lowest elevation, a horizontal path beam is reflected into the receiver optical system to provide a monitor signal, which is also fed to the recorder.

A directional baffle is mounted above the photocell to ensure that only light from directly above is collected by the mirror within a cone of acceptance of 2°.

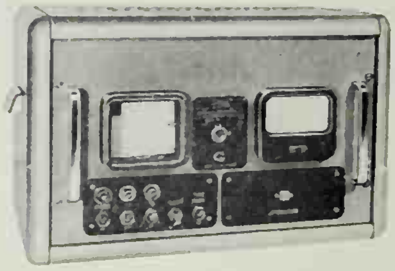


The receiver unit is fully weatherproofed and includes solar radiation shielding

Recorder

This unit is normally located in the airfield control tower, or in the meteorological building, and presents a continuous recording of the cloud base height in the vicinity of the airport.

The recording unit accepts both the receiver output signal and the transmitter reference signal. Co-incidence of these two signals in the sensing circuit generates an output signal which causes the pen to mark the paper. The monitor signal also produces a record to indicate that the equipment is operating when cloud is not present, and is also used as an indication of visibility.



The recorder unit provides remote switching for both the above units

Specification

Power source: 200–250 V ac 50 Hz single-phase
Max consumption from mains: transmitter 800 VA; receiver 200 VA; recorder 125 VA
Cloud base: limits of measurement on a 106 m (350 ft); base line are 15–1200 m (50–4000 ft)
Transmitter light source: 24 V, 200 W tungsten filament, quartz iodine lamp
Chart width: 76 mm (3 in)
Chart speed: 76 mm/h (3 in/h)
Chart duration: 7 days recording without replacement
Scanning period: 1 minute/cycle (making two measurements)
Overall instrumental accuracy of height indicated on chart: ±2·1 m (7 ft) at 15 m (50 ft) height; ±9·1 m (30 ft) at 150 m (500 ft) height; ±30 m (100 ft) at 1200 m (4000 ft) height
Weights: transmitter 145 kg (320 lb); receiver 145 kg (320 lb); recorder 32 kg (70 lb)
Dimensions: transmitter 1220 × 889 × 965 mm (48 × 35 × 38 in); receiver 1000 × 1270 × 965 mm (40 × 50 × 38 in); recorder 610 × 381 × 356 mm (24 × 15 × 14 in)

AIRTECH LIMITED
Haddenham, Aylesbury, Buckinghamshire, England
Telephone: Haddenham 422 Cables: Airtech Haddenham Telex: 83223

AIRTECH

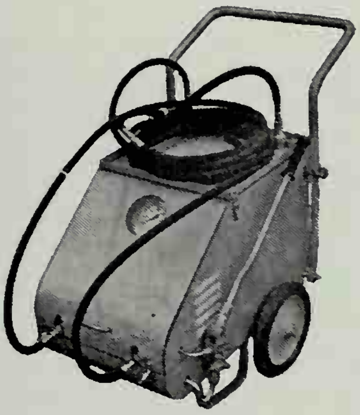
Servicing trolleys

for aircraft hydraulic systems

The current range of HML servicing trolleys has evolved by gradual development through military and industrial demand. The experience gained, for example, in building hydraulic test rigs for the Concorde airliner, the VC10 and Jumbo jets on the civilian side, the Jaguar and the Harrier on the military, is of benefit in the design and construction of test apparatus for the armed services.

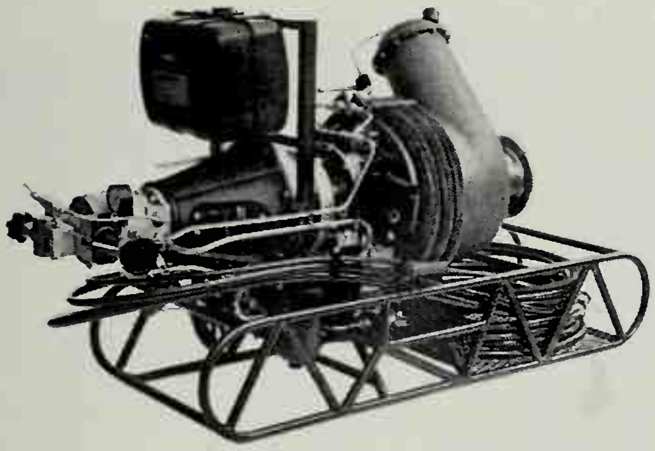
It is obvious that no single piece of hydraulic test equipment is suitable for all operational situations. The availability of a wide range of equipment is both sensible and practical.

The trolleys shown here are a selection from the HML range. This company also specialises in custom-built test rigs for every hydraulic testing application.



Mk 1 Minirig

Compact, lightweight hand-trolley powered by petrol engine or electric motor, supplies up to 4·5 litres/min at 280 kgf/cm^2 (1 gal/min at 4000 lbf/in^2).



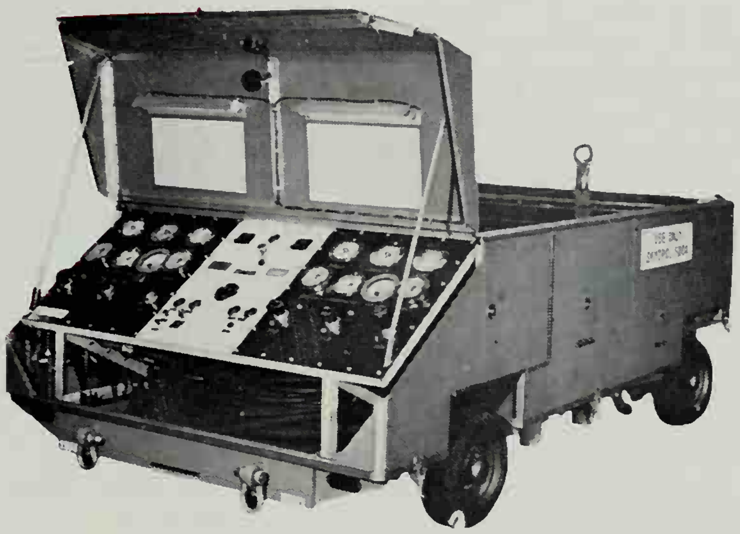
Hydraulic and electric generator packs

Powered by gas turbine for electric or hydraulic power.

Turbine: highly mobile, very compact and simple to operate. Built-in acceleration and temperature limiters and overspeed protection device. Variable speed control optional. Can run on various aviation fuels. Consumption about 61 kg/h (135 lb/h).

Electric pack: three versions are available at 22·5, 30 and 40 kVA, giving 115/200 V, 400 Hz.

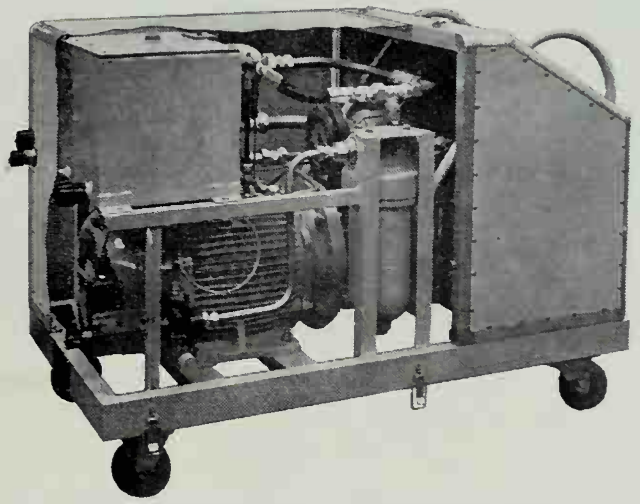
Hydraulic pack: delivers 73 litres/min at 210 kgf/cm^2 (16 gal/min at 3000 lbf/in^2). Maximum continuous operating preesure 350 kgf/cm^2 (5000 lbf/in^2).



HTD 108 and HTE 109

The 108 is diesel-powered, the 109 electrically powered. Primarily for large aircraft with a return line pressurised to 2–7 kgf/cm^2 (30–100 lbf/in^2). Provides either two supplies 0–55 litres/min at 14–246 kgf/cm^2 (0–12 gal/min at 200–3500 lbf/in^2), or one of 0–109 litres/min at 14–246 kgf/cm^2 (0–24 gal/min at 200–3500 lbf/in^2).

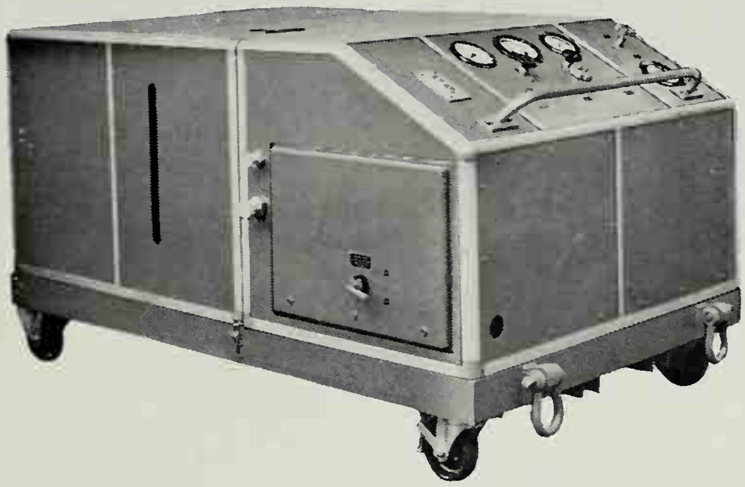
Dimensions: 3·2 × 1·83 × 1·07 m (10·5 × 6 × 3·5 ft).



HTE 120

A versatile, inexpensive, lightweight trolley for smaller aircraft. Output 0–36 litres/min at 210 kgf/cm^2 (0–8 gal/min at 3000 lbf/in^2).

Dimensions: 1·4 × 0·76 × 1·0 m (4·6 × 2·5 × 3·20 ft).



HTE 125

A compact, 40 hp electrically-powered servicing trolley delivering up to 73 litres/min at 210 kgf/cm^2 (16 gal/min at 3000 lbf/in^2).

Dimensions: 2 × 1·25 × 1·05 m (6·5 × 4·1 × 3·5 ft).

HML (ENGINEERING) LIMITED
St. John's Road, Isleworth, Middlesex, England
Telephone: 01-560 3011 Telex: 933887

HML

Staging and docking system

for aircraft maintenance

The unique 'Hi-Way' unit form aluminium staging system made by Martin-Thomas Limited is being utilised by many air forces and service organisations throughout the world. Lightweight, heavy-duty staging components enable large structures to be dismantled and stowed in transport aircraft for air transportation to new locations. Kits of components are capable of being constructed in many different configurations to give access to all areas on an aircraft. Quick and safe erection are ensured by the patented 'Hi-Way' snap-action hook, which enables vertical frames to be joined together without the use of nuts or bolts. Few tools, if any, are required to assemble the equipment.

Stagings and docks are fabricated from non-corrosive 50mm (2in) outside diameter aluminium alloy tubing (HE30WP, HV30WP, HT30WP) and castings (LM8) conforming to British Standards BS1139, Section 7.

Overhaul and major maintenance docking

Designed for full coverage of all areas on the aircraft simultaneously, i.e. full-length nose-to-tail fuselage dock, complete wing coverage, engine docks, tail docks, etc. All this mobile docking incorporates facilities for functioning of control surfaces, power plant removal, and opening of all access panels. The docking can be designed for any aircraft, whether on wheels or on jacks.

Minor maintenance stagings

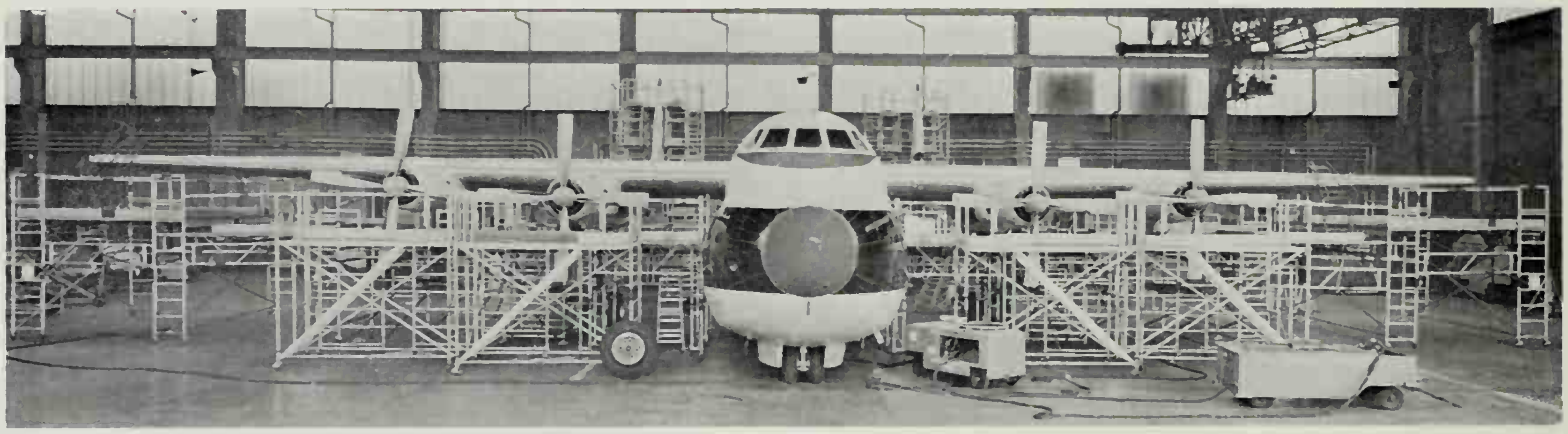
Individual mobile runabout stagings may be used to cater for various important areas on any aircraft, and can also be manufactured to allow for towing on aircraft dispersal areas.

Fli-Way airportable kits

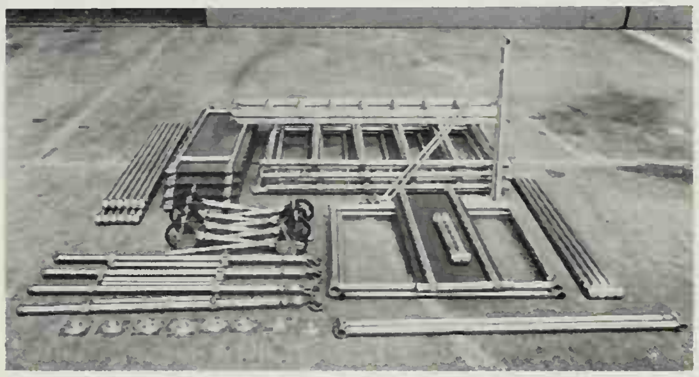
These kits are supplied as light-weight units for use on large or small aircraft, and one kit is capable of being successfully used on many areas of a number of different aircraft types. A typical kit which could be used on large aircraft such as the VC10 or Hercules C130 would weigh approximately 363kg (800lb) and have a cubic capacity of approximately 6·65m^3 (235ft^3).

Servicing steps and towers

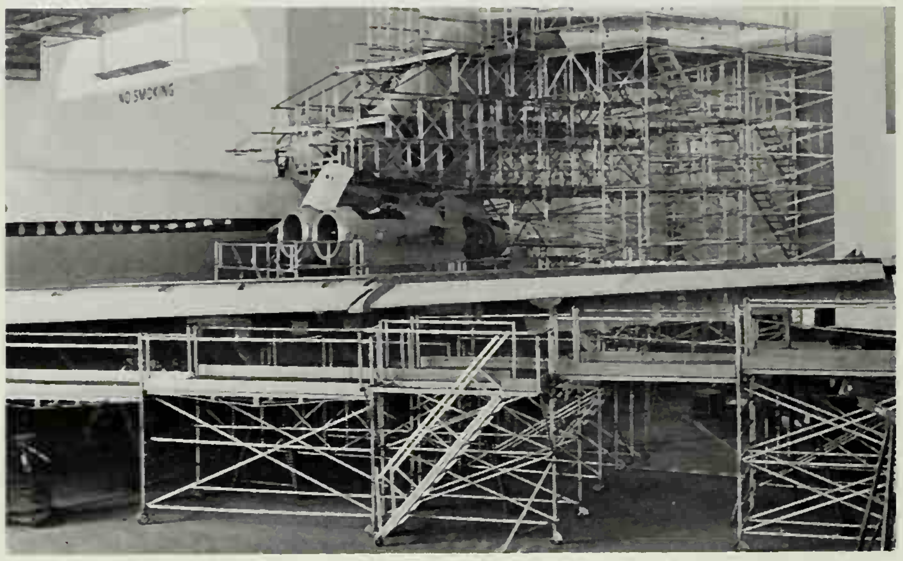
A full range of servicing steps, both standard aircraft maintenance entry type and special light aluminium folding steps, are produced. The aluminium folding steps can be purchased in kit form for assembly by the customer.



Hawker Siddeley Argosy aircraft major servicing dock comprising lightweight 'Hi-Way' stagings covering all areas on the aircraft



Typical selection of 'Hi-Way' aluminium staging components, being one of the range of standard kits of parts used in the construction of aircraft docking. This particular kit is utilised as a Fli-Way airportable staging for servicing, maintenance or salvage of strike or small aircraft. Many different configurations may be constructed from this kit

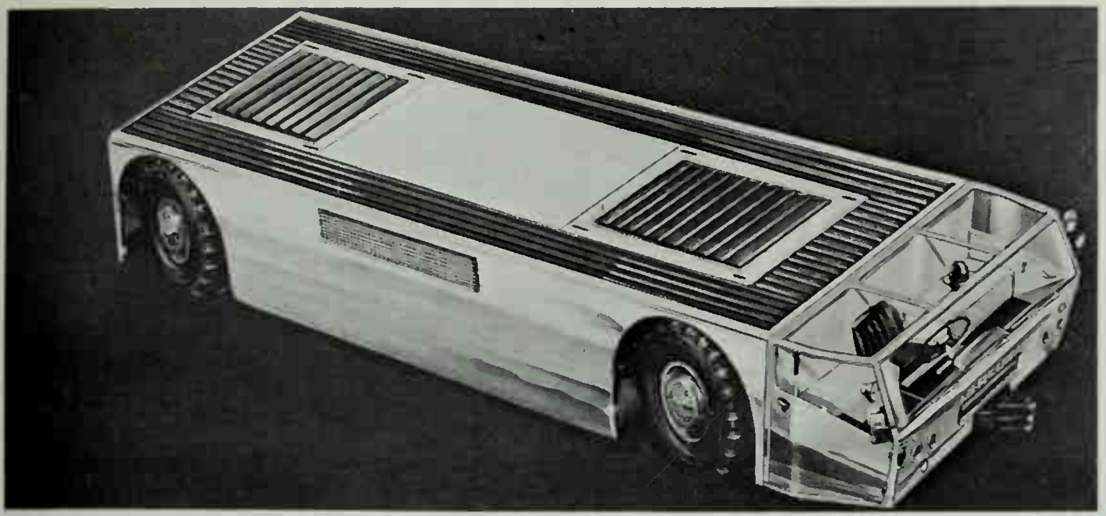


British Aircraft Corporation VC10 aircraft tail, engine and wing docks

MARTIN-THOMAS LIMITED
Aviation Division
South Way, Walworth Industrial Estate, Andover, Hampshire, England
Telephone: Andover 4014 Cables: Hiway Andover Telex: 47277

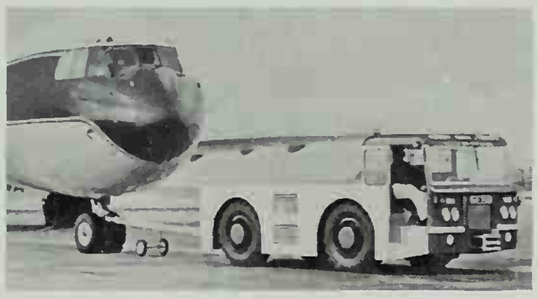
Airfield equipment

for aircraft and cargo handling



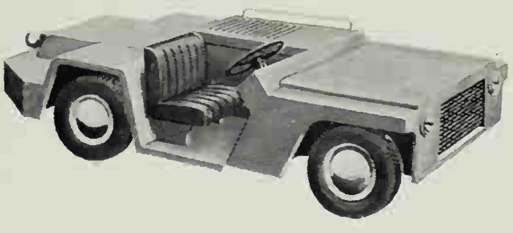
Airtugs

The Mercury MD 400/500 (left) is the latest in a long line of Mercury aircraft towing tractors. Capable of a tractive effort from 18 140 to 22 680kg (40 000–50 000lb) drawbar pull, these airtugs are intended to meet the needs of the largest military and civil jet transport aircraft. Features include four-wheel drive, four-wheel powered steering, 75kV ground power unit (within the body of the vehicle) and automatic transmission, exceptional driver comfort and visibility. Elevated cab, radio communication system, searchlights, etc. are optional extras.



Mercury Airtug MD 300 (above) is designed to provide 13 600kg (30 000lb) draw-bar pull. It is of proven performance and is operating throughout the world. Features include spacious driver compartment for driver plus three crew, all-round visibility, big, remote 'V' diesel engine for low noise level, torque converter, power shift transmission, thermostatic cooling, full power steering, etc.

Mercury Airtug MD 100/130 (above) gives from 4500 to 5900kg (10 000–13 000lb) draw-bar pull, dependent on the ballast weights fitted. Models MD 40/60 and MD 20/30 give draw-bar pulls from 900–5900kg (2000–13 000lb). All these Mercury Airtugs have been proven over many years in a wide variety of airfield ground-handling operations, from medium-sized aircraft to trains of baggage trailers.



Mercury MD200 with draw-bar pull of 9070kg (20 000lb)

Industrial tractors and trucks

Mercury MD20/30 with draw-bar pull up to 1360kg (3000lb)

Mercury MD40/60 with draw-bar pull up to 2720kg (6000lb)

Mercury Shuntug can move up to fifteen 10-ton wagons

Mercury T3 truck can carry 2720kg (6000lb)

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MERCURY AIRFIELD EQUIPMENT LTD
Woodbridge Works, Guildford, Surrey, England
Telephone: Guildford 71271   Cables: Mercury Guildford   Telex: 85211

Aircraft refuellers

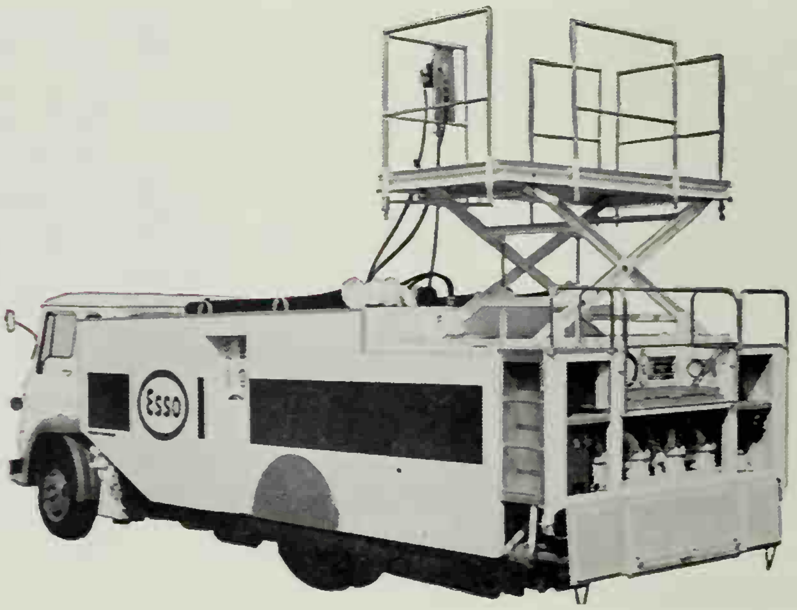
of large capacity and high flow rates

Gloster Saro's wide experience in the design, development and manufacture of aircraft fuellers has made them first choice by the world's leading oil companies. Produced in lightweight aluminium alloy, these units have considerable anti-corrosion and anti-condensation properties which increase their operating life and reduce maintenance costs to a minimum. They can also be fitted with a wide range of safety devices.

Gloster fuellers are already in service at the major airports in 30 countries throughout the world. The current range of equipment is designed to meet the exacting demands of the new generation of 'jumbo' and supersonic aircraft of the 1970s.

Gloster air transportable fueller
This 13 640 litre unit (shown above) was produced in co-operation with the British Ministry of Technology to meet the demand for a low-profile, lightweight fueller which is air-transportable. Fuelling is achieved either by the pressure underwing method or the open-line refuelling system.

The Gloster Jumbo jet fueller
This articulated unit (not illustrated) is the largest fueller in the Gloster range, having a capacity of 80 100 litres in a single unit. With a fuelling rate of 4550 litres (1000 gal) per minute it can meet all known aircraft requirements. The fueller can be fitted on a wide range of chassis and the rear bogie can incorporate self-steering facilities for high manoeuvrability.



Gloster Hydrant dispenser
Available in a range of sizes giving fuelling rates of up to 4550 litres (1000 gal) per minute, and mounted on a rigid, articulated or drawbar trailer chassis, the dispenser (shown above) is designed to service the larger 'jumbo' size aircraft of the 1970s.

The Gloster Hydrant dispenser method of fuelling reduces airfield vehicle congestion with its attendant danger of aircraft damage.

Gloster Somerset Mark III fueller
Designed for mounting on a wide range of vehicle chassis and constructed of lightweight aluminium alloy, the fueller has a capacity of 18 180 litres with a pressurised fuel delivery capacity of 3860 litres per minute.

The Somerset can be equipped for open-line fuelling in addition to the pressurised system.

Coupled to a specially constructed range of trailers, the unit has a total combined capacity of up to 62 300 litres.

TEXACO
TEXACO

A member of the Hawker Siddeley Group
GLOSTER SARO LIMITED
Vehicle Division
Hucclecote, Gloucester, GL3 4AD, England
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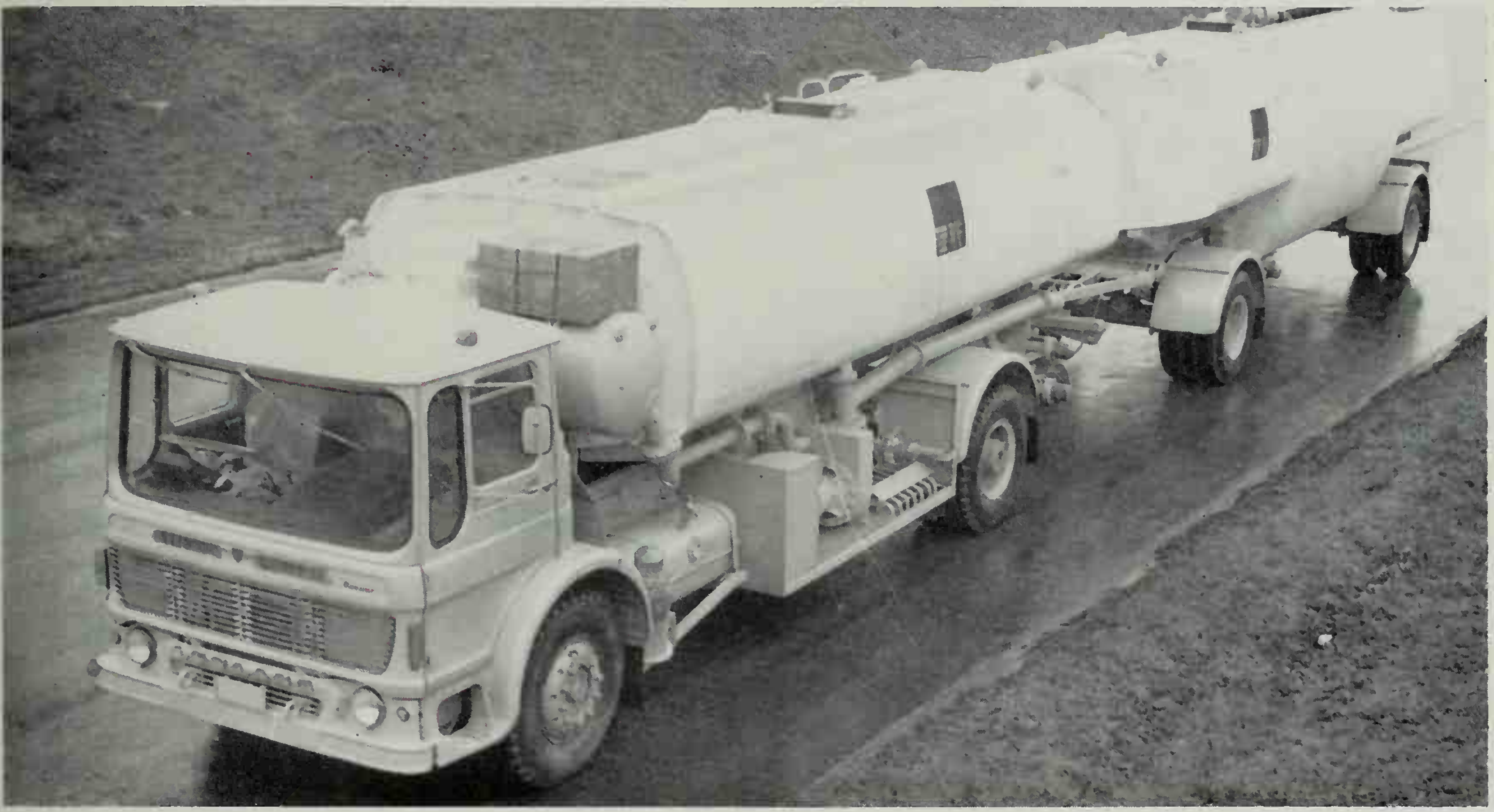
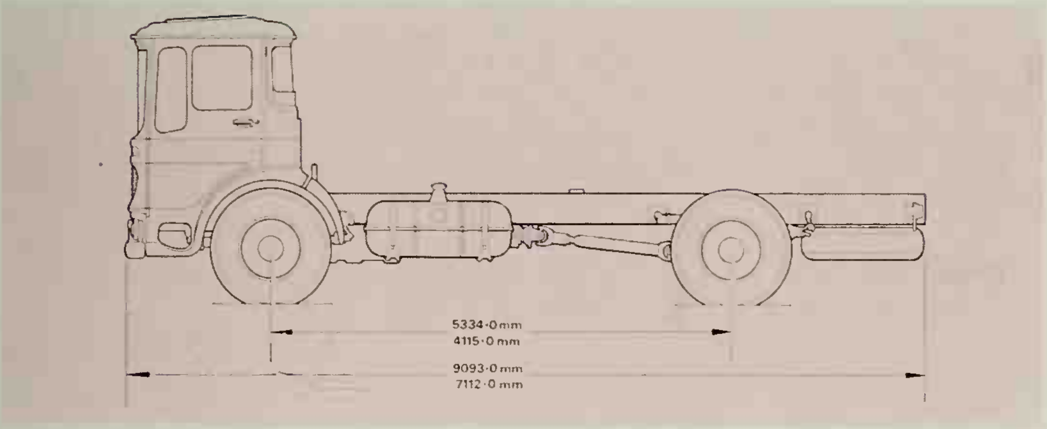
Beaver

Leyland haulage chassis for airfield refuellers





The Leyland Beaver is a rugged 4 × 2 chassis available with 5·33 and 4·11 m (210 and 162 in) wheelbase lengths, powered by the Leyland 680 six-cylinder engine. Drive is through a single dry plate clutch to a constant-mesh gearbox with five forward and one reverse speed. Overdrive and crawler gears are optional. Air brakes are standard and steering is hydraulically power-assisted. The drawbar trailer is of chassisless construction, giving a low weight/payload ratio and is mounted on two single axles. An engine-driven pump delivers fuel under pressure at a rate of 2730 litres (600 gal) per minute.

Specification

Engine
Leyland 680 six-cylinder high-performance diesel
BS AU141 rating: 200 bhp at 2200 rev/min
Maximum torque: 72·6 kgf m (525 lbf ft) at 1400 rev/min

Clutch
Single dry plate 413 mm (16·25 in) dia

Gearbox
Leyland five-speed constant-mesh wide-ratio heavy-duty
Ratios: 5th 1:1, 4th 1·69:1, 3rd 2·755:1, 2nd 4·613:1, 1st 7·243:1
Reverse: 6·50:1; overdrive and crawler gears optional

Suspension
Symmetrical semi-elliptic leaf springs with hydraulic telescopic double-acting shock absorbers (front only)

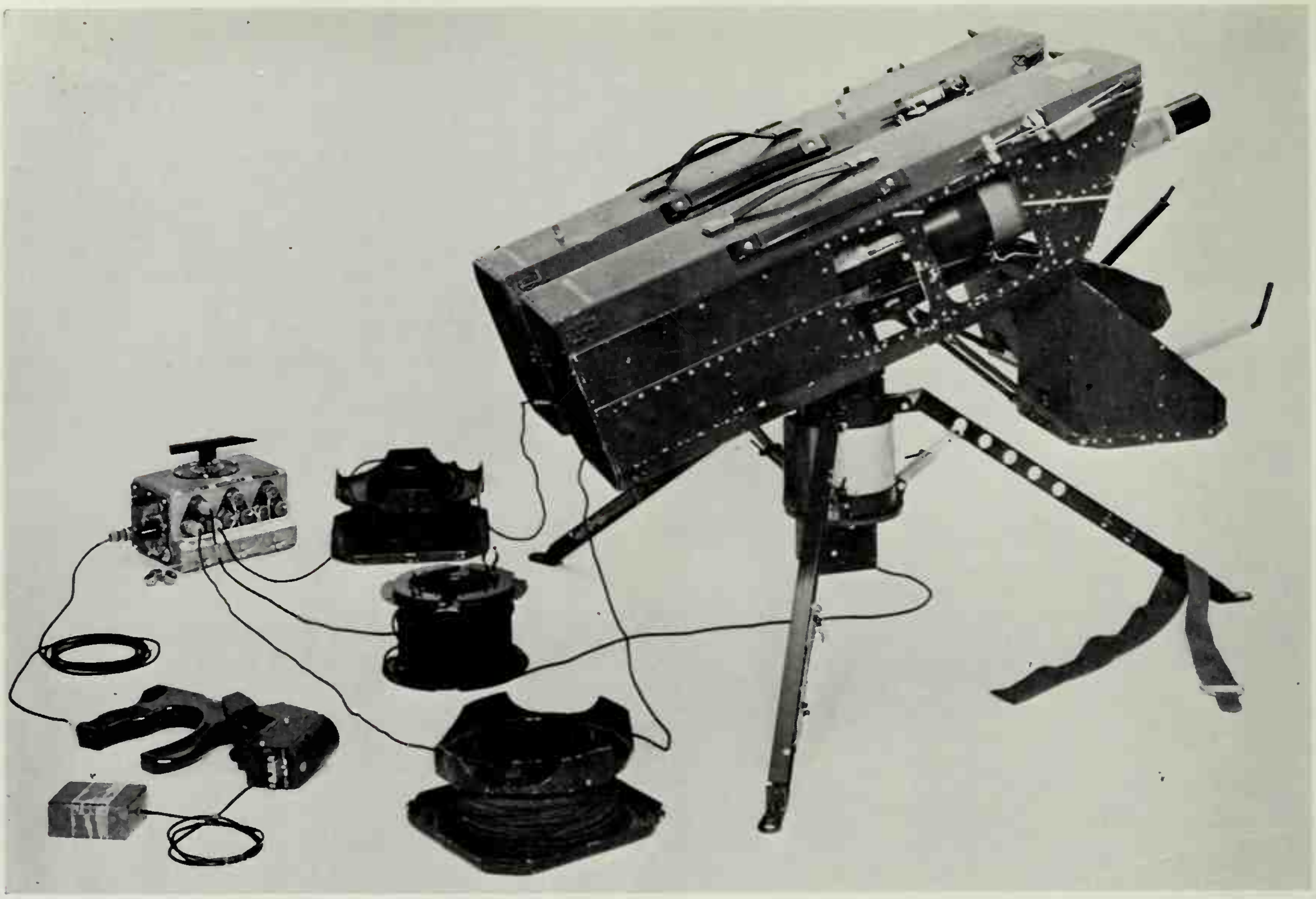
Tyres
10·00 × 20 in specially marked radial ply
12·00 × 20 in for airfield use only

LEYLAND MOTORS LIMITED
Military Sales Division
Berkeley Square House, Berkeley Square, London, W1, England
Telephone: 01-499 6050 Cables: Leymotors London W1 Telex Telex: 22498

BRITISH LEYLAND

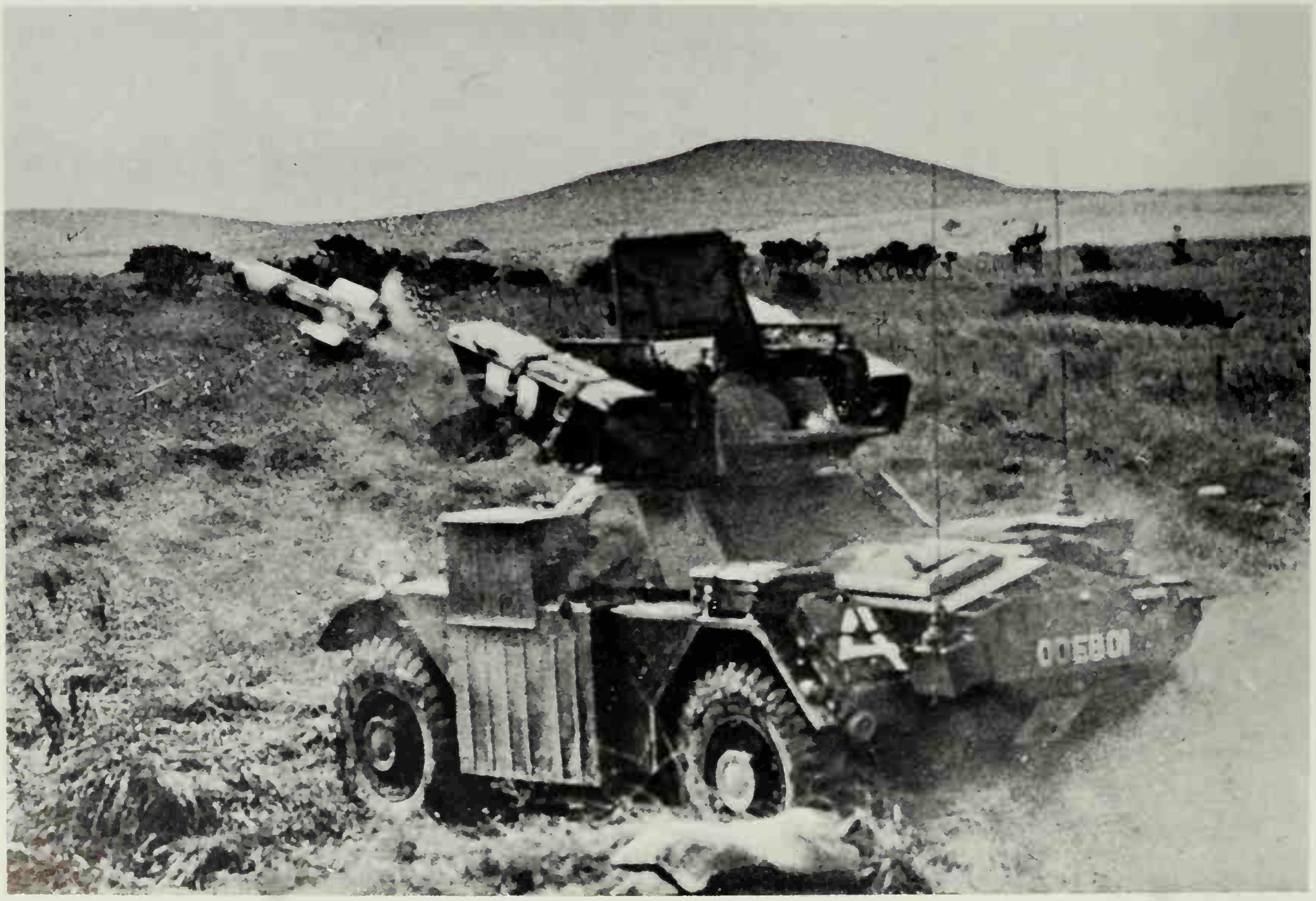
Section 22

Guided weapons and equipment



Above: Vigilant on traversable launcher. Each launcher is capable of mounting and successively firing two missiles. The second of two targets separated by 45° is engaged within five seconds of the first being destroyed

Below: Vigilant firing from a Ferret scout car



Vigilant

man-portable anti-tank wire-guided missile

Vigilant is a wire-guided anti-tank missile—the most lethal man-portable weapon of its type. It is lethal against the heaviest battle tank, and is instantly ready as no field assembly or tests are required. A gyro-stabilised control system gives Vigilant a very high hit ratio, even at difficult short ranges and allows a good separation between operator and weapon. Its easy-to-learn control system also reduces training costs.

Vigilant can be carried into action by paratroopers who can engage in attack within 30sec of landing, deployed in scant natural cover and free from counter fire. Equally well, Vigilant's small size and weight make its installation on light fighting vehicles simple and effective.

In service with the British Army, both with the Infantry and the Royal Armoured Corps, Vigilant has also been supplied to the defence forces of Finland, Kuwait, Libya and Saudi Arabia.

Performance

Listed below are the basic requirements of a modern anti-tank guided weapons system, and against each requirement is shown the capability of Vigilant. The outstanding performance of Vigilant is clearly evident from this juxtaposition.

Basic requirement:	**Vigilant capability:**
Lethality	Will destroy the heaviest battle tank
Accuracy	Velocity control ensures a high hit rate
Reliability	Built into the system
Small size and low weight	Only truly man-portable guided missile system
Good maximum range	Will kill out to 1375m (1500yd)
Good minimum range	Trainees score hits at 200m (220yd)
Good azimuth coverage	±35° in azimuth
Good elevation coverage	±10° in elevation
Separation capability	
Concealment	Controller can be concealed up to 63m (70yd) away from the weapon. There is no smoke or flame and the system is immune to electronic counter measures
Immunity to counter measures	
Ease of use and training	With training any soldier can effectively use the weapon system. No specia skills are required
Semi-automatic facility	Easily incorporated
Ease of installation in vehicles	The weapon system is extremely flexible in its applications
High rate of fire	Immediately ready for use
All-weather and night operation capability	Well proven
Pan-climatic operation	Can be used in all climates
Storage and maintenance	As normal gun ammunition
Cost effectiveness	Extremely high
Easily introduced into service	Well proven

Vigilant firing from a ground launcher

BRITISH AIRCRAFT CORPORATION LIMITED
Guided Weapons Division
Six Hills Way, Stevenage, Hertfordshire, England
Telephone: Stevenage 2422 Cables: Britair Stevenage Telex: 82125

BAC

The lightweight design of Rapier makes it readily transportable by conventional transport, on trailers, half-tracked vehicles or tracked armoured vehicles; it is equally suitable for transport in aircraft. At the same time, its construction is sufficiently robust to ensure that it is fully capable of withstanding the stresses of its operational role. This, combined with built-in reliability, results in minimum maintenance requirements, thus reducing cost and increasing operational effectiveness.

One of the most important requirements of modern weapons systems is their capability for operation by a minimum number of personnel. Hence, rapid deployment in action and extreme simplicity of operation are two of the special features of the system, which is operated in action by only one man. For deployment and reloading, a minimum detachment of three men is required, all of whom act as relief operators.

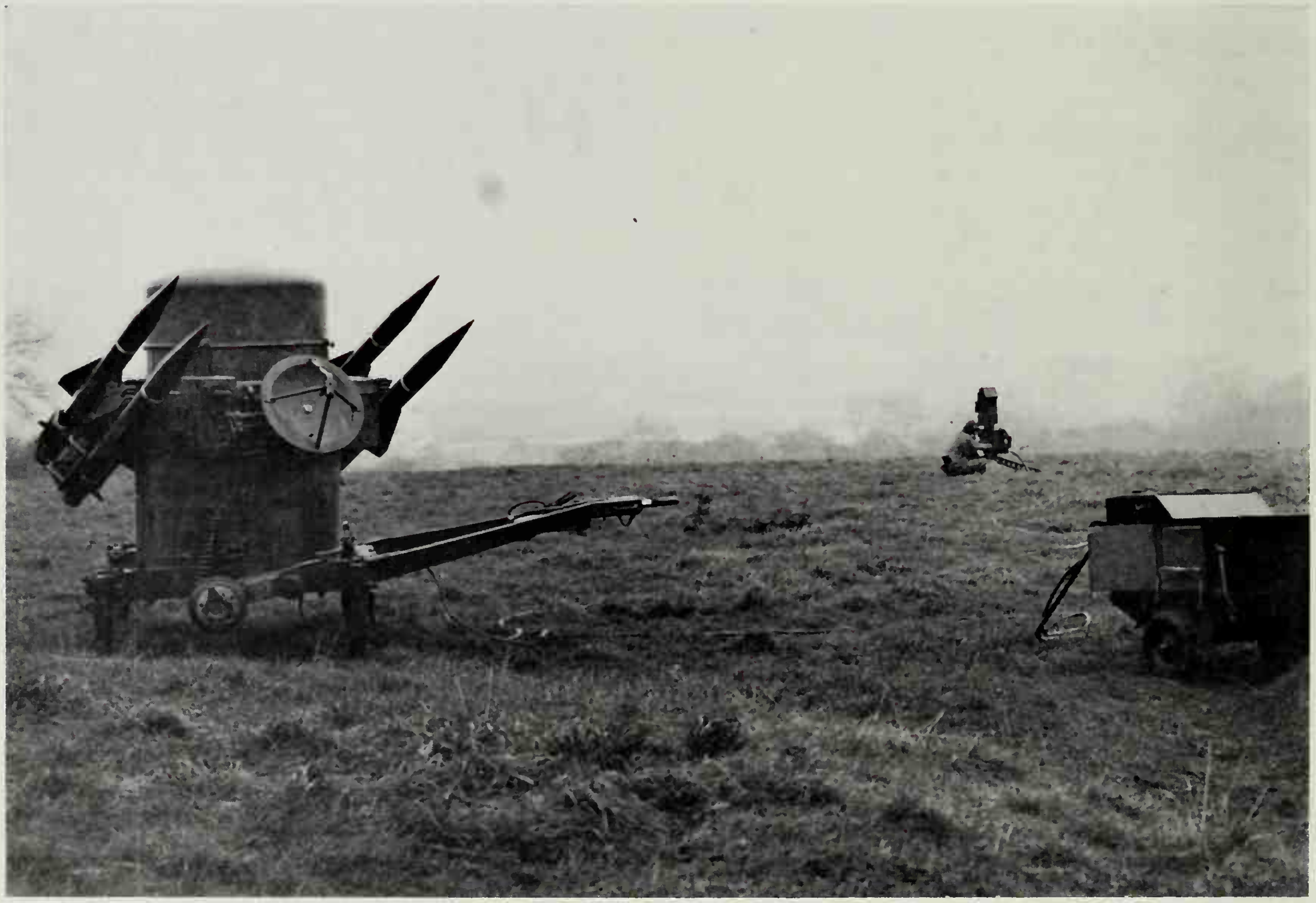
In operation, the system incorporates a highly efficient search radar which employs a vertical fan-shaped beam to scan continuously a volume of space about the horizon. Any target is automatically detected and interrogated and, if no friendly IFF response is received, an alarm is sounded to alert the operator. At the same time, the optical head of the tracker and the missile launcher are automatically aligned on the target. The operator will see the target in the optical sight and will switch to manual tracking of the target. On receiving a signal from the computer that the target is engageable, the operator fires a missile and continues to track the target, this continued tracking ensuring that the missile is automatically directed to impact at the point of his aim.

Rear-mounted flares on the missile are seen in the tracking head. Any deviation of the missile from the sight line to the target is measured and processed by the computer to produce missile commands which are transmitted to the missile by a command link to maintain the missile on a collision heading with the target. Practical experience with the joystick control and optical system of Rapier, against difficult manoeuvring targets, has confirmed an extremely high order of smooth and accurate tracking.

'Blind-fire' capability

British Aircraft Corporation Ltd and GEC-Elliott Space and Weapon Systems Ltd are now developing a new radar tracking system for Rapier, to allow targets to be engaged in darkness and poor visibility. The new tracking system will be available as an add-on feature to the standard Rapier production equipment, both optical and radar guidance thus being available. Full mobility and air-portability are being maintained.

In cost effectiveness terms this latest development of the Rapier system will be far in advance of any known world competitor. Feasibility and project studies and trials of the new system have already been completed.

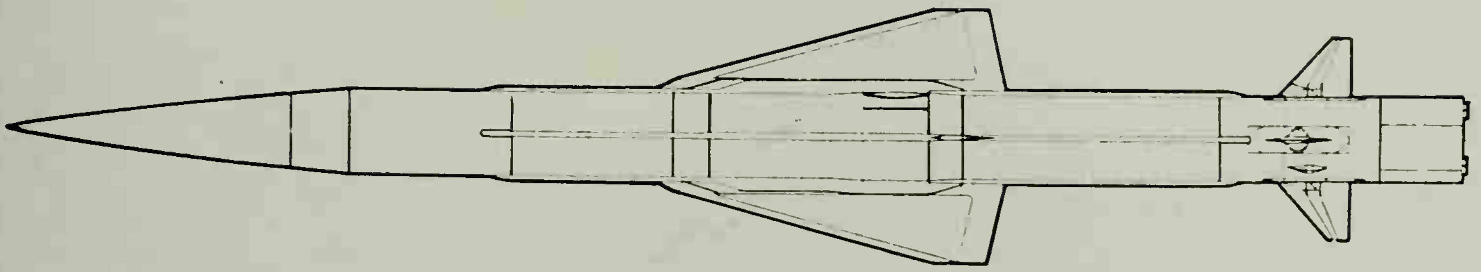


Capable of completely independent action, and suitable for use in sophisticated integrated systems, Rapier combines all the advantages of high mobility, faster reaction time, great accuracy and supersonic speed. Thus it is one of the best means of defence against the elements of a surprise attack. Rapier can effectively combat low-level air strikes from tree top height, yet it is also able to engage accurately aircraft flying at several thousand metres. Versatile in application, it provides a protective cover against supersonic as well as subsonic aircraft

Rapier

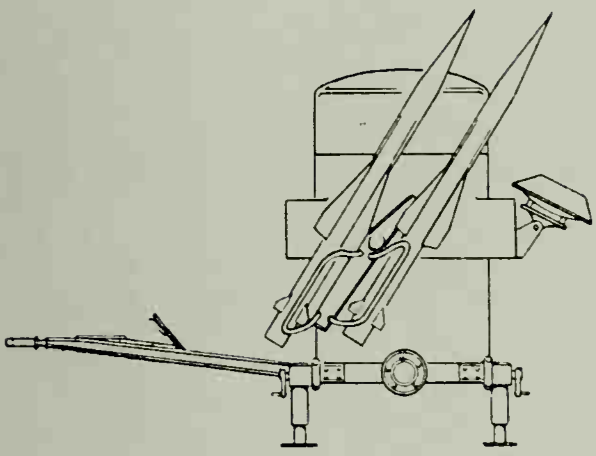
low-level anti-aircraft guided missile

Rapier is the most important tactical anti-aircraft guided weapon system in production today. It was developed to satisfy a Ministry of Defence requirement for a low-cost system with sufficient flexibility in its operational capability to be effective against low-level attacking supersonic and manoeuvring aircraft. Currently in production for the British Army and for the Royal Air Force, Rapier will also form part of the British Aircraft Corporation Air Defence System for overseas customers.



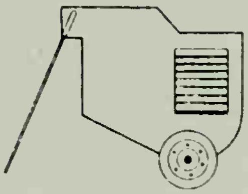
Missile

Span	38cm (15in)
Length	224cm (88in)
Diameter	12·7cm (5in)



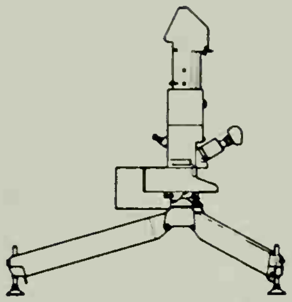
Fire unit

Length	394cm (155in)
Height	213cm (84in)
Width	181cm (71·5in)



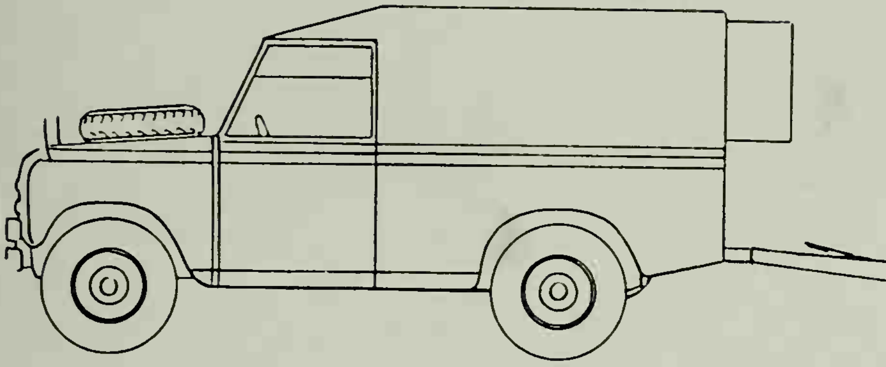
Power unit

Length	81cm (32in)
Height	100cm (40in)
Width	76cm (30in)



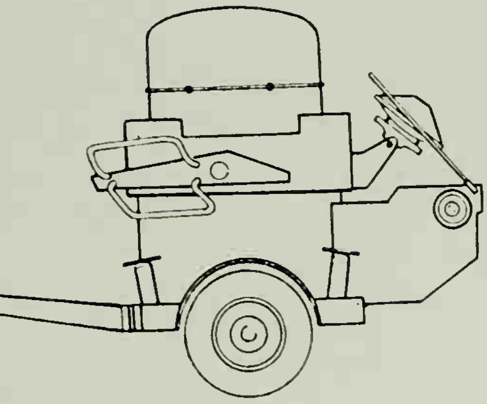
Tracker

Length	122cm (48in)
Height	157cm (62in)
Width	60cm (24in)



Towing vehicle, tracker and missiles

Length	513cm (202in)
Height	193cm (78in)
Width	165cm (65·5in)
Weight	2676kg (5900lb)



Fire and power unit

Length	394cm (155in)
Height	213cm (84in)
(183cm (72in) with radome lowered)	
Width	181cm (71·5in)

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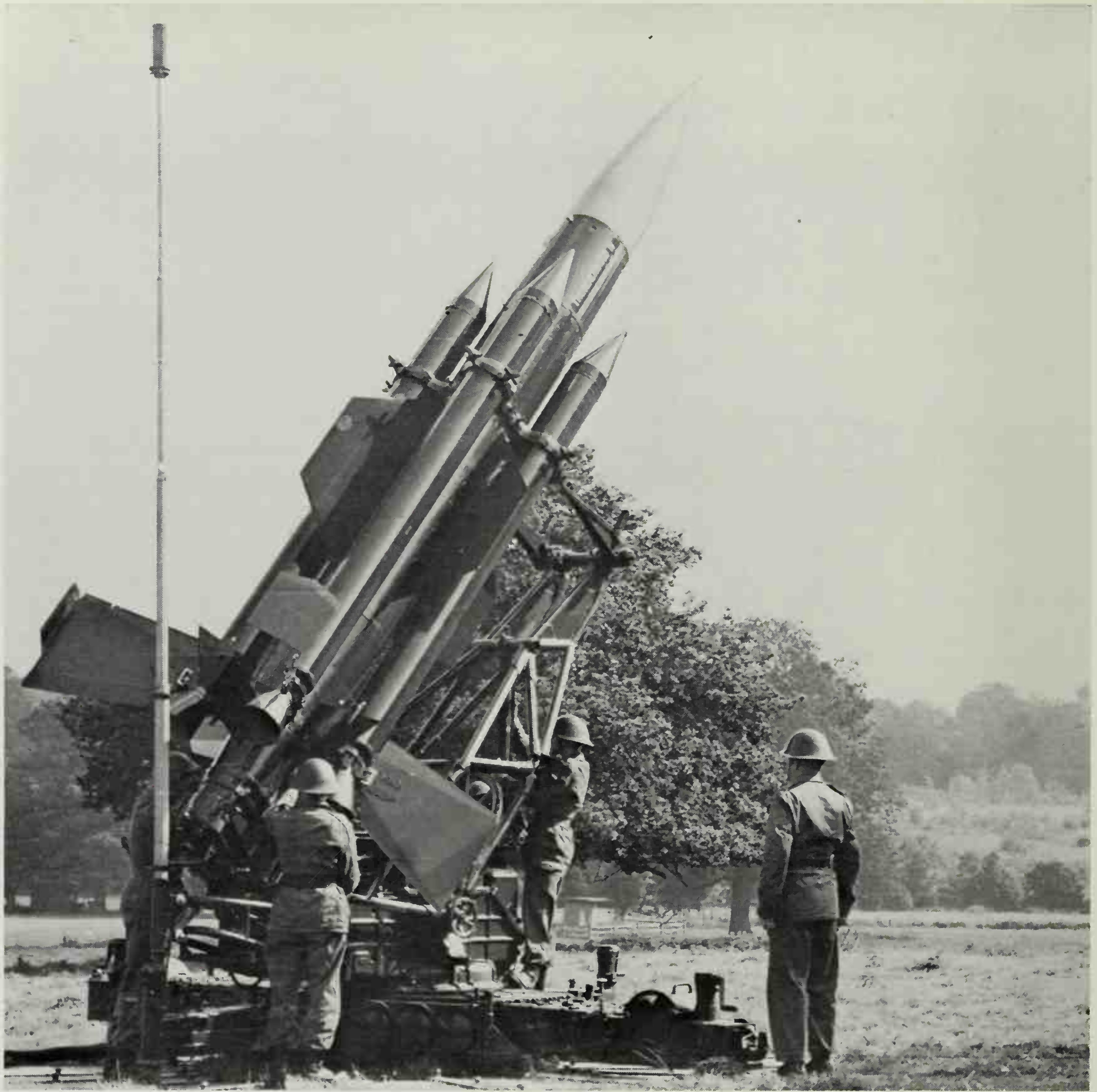
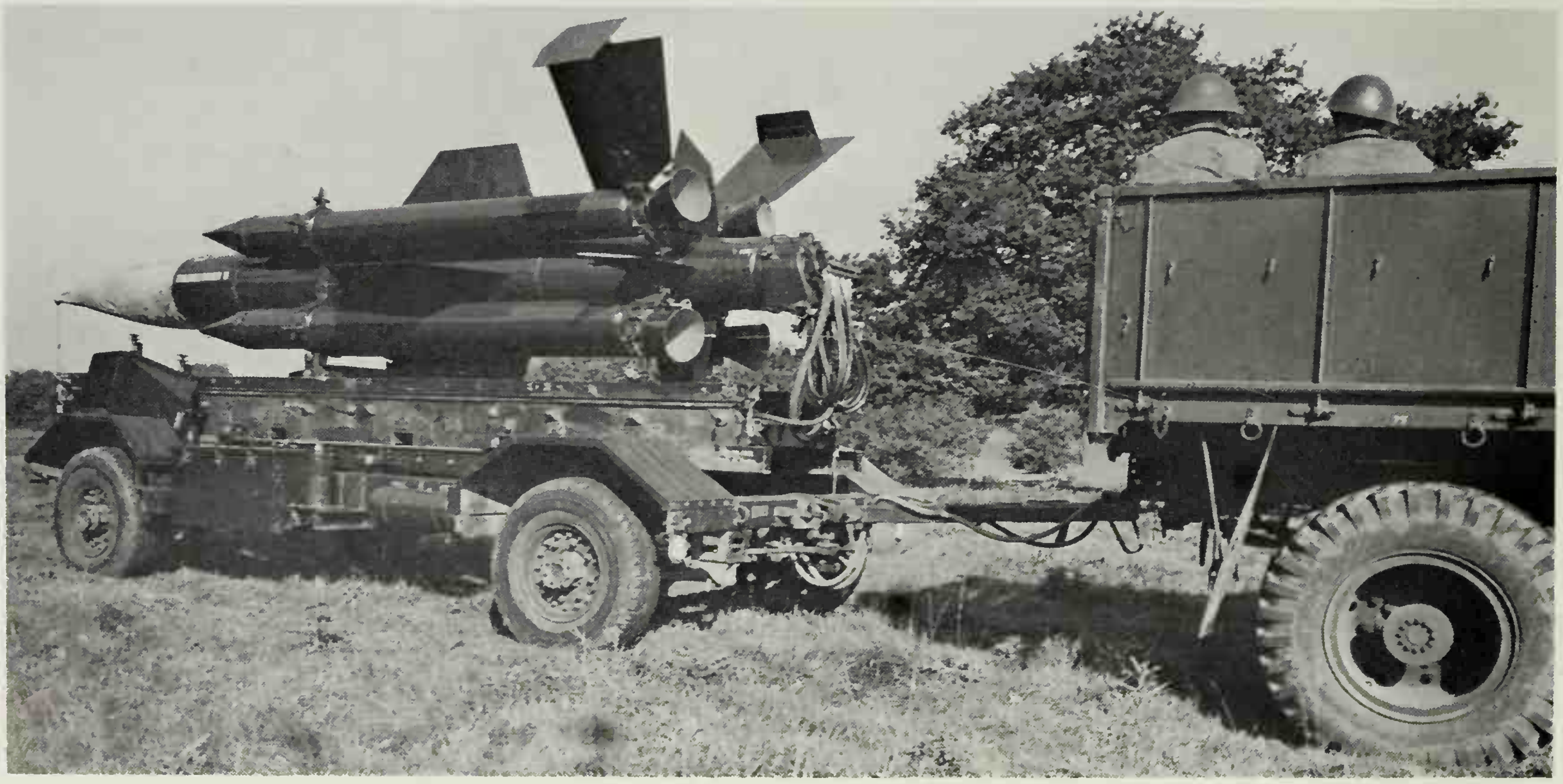


Thunderbird is fully mobile and air-transportable



Thunderbird

medium- to high-level anti-aircraft guided missile

Thunderbird is the most versatile anti-aircraft guided weapons system in the world today. It is lethally effective against supersonic air attacks and is unique in its flexibility and its capability for rapid deployment. Thunderbird is fully mobile, designed to withstand rigorous cross-country travel, and is also light enough to make it suitable for transport by air.

Part of Thunderbird's flexibility lies in the fact that it is capable of fulfilling a wide variety of operational roles. It has its own tactical radar and can serve as an autonomous firing unit in the field as readily as it can be integrated into a full-scale area defence system. Hence, it can defend large strategic targets, be re-deployed rapidly to provide a defensive umbrella for beach landing or support a fast-moving front line.

For maximum mobility, the system has been designed to have the same ruggedness as the most mobile army equipment, and the number of special design features make it easily adaptable for any method of transportation, including aircraft and standard railway trucks.

All electronic and mechanical components of Thunderbird have been subjected to the most stringent environmental tests, to ensure that they satisfy the high reliability standards which were laid down for the system. Special encapsulation techniques have also been incorporated to enable all Thunderbird components to withstand extreme climatic conditions to meet operational requirements in any part of the world.

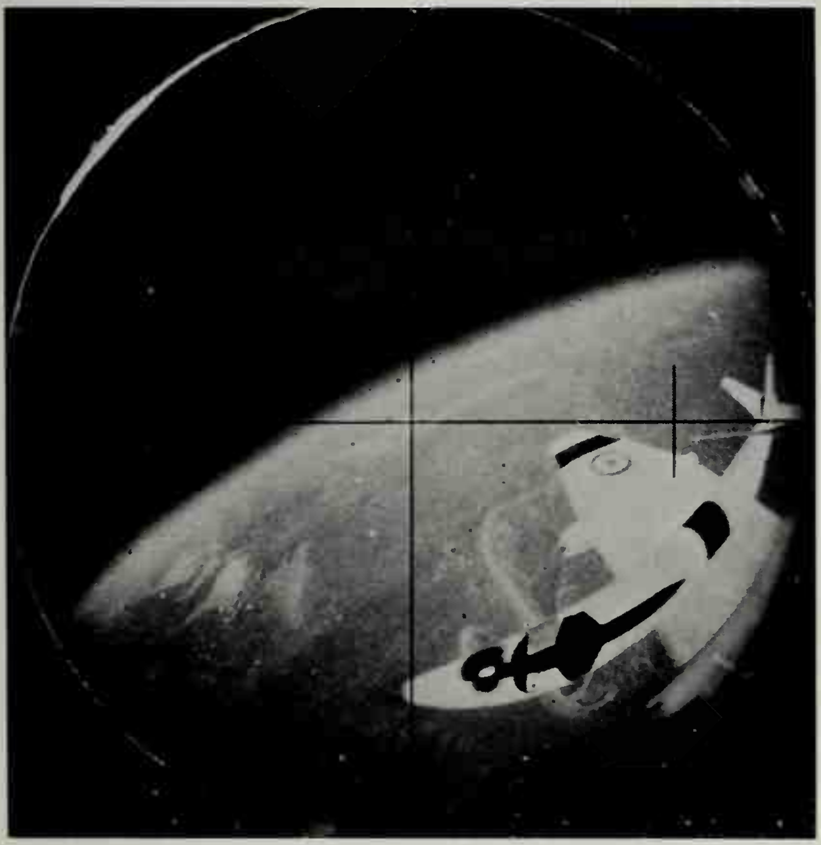
Economy of manpower, so essential in modern defensive warfare, was another important design consideration for the system. In action, Thunderbird can be operated by a small number of regimental soldiers.

Because of its high reliability, Thunderbird makes possible an effective saving in technically skilled personnel. The repair philosophy is one of repair-by-replacement, and the construction of the missile is such that the main assemblies can be quickly and easily repaired or replaced under field maintenance conditions. Diagnostic facilities are incorporated in the ground equipment to assist in the easy replacement of components on equipment in action.

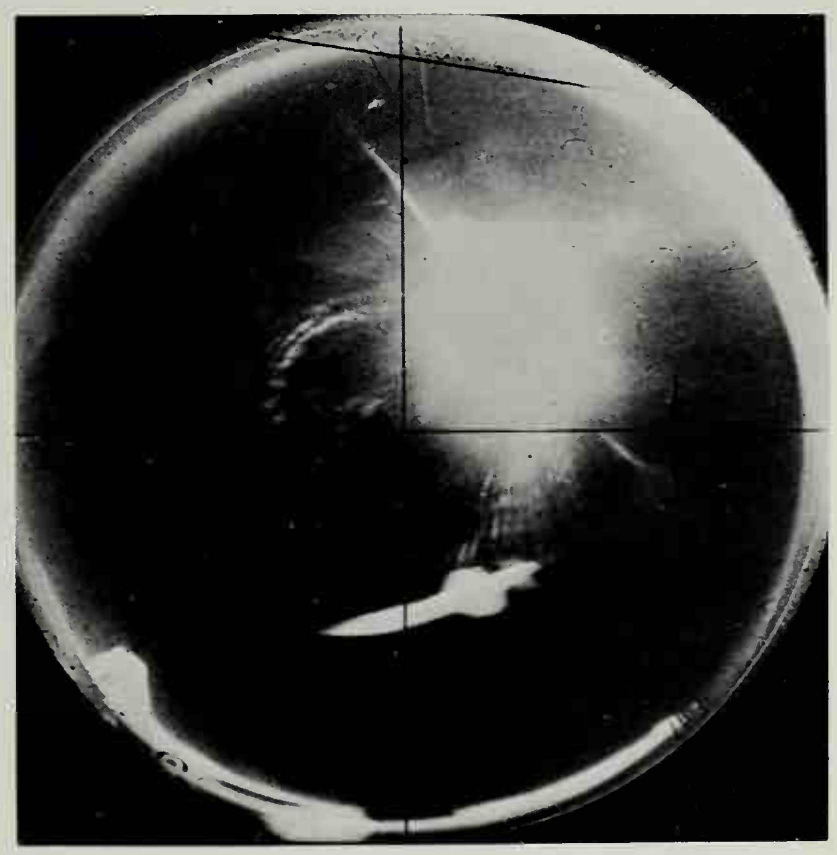
Even the first Thunderbirds of the Royal Regiment of Artillery proved the unquestionable lethality of the system; later, more highly developed Thunderbirds have fully utilised recent important progress in the state of the defence art.

Today Thunderbird is the chosen major anti-aircraft weapon for the British Army, has seen service with the defence forces of Saudi Arabia and has been selected for overseas customers as part of the British Aircraft Corporation Air Defence System.

Missile shadow outlined on a target—taken by the missile camera during trials



Missile taken by the target camera during the same trial



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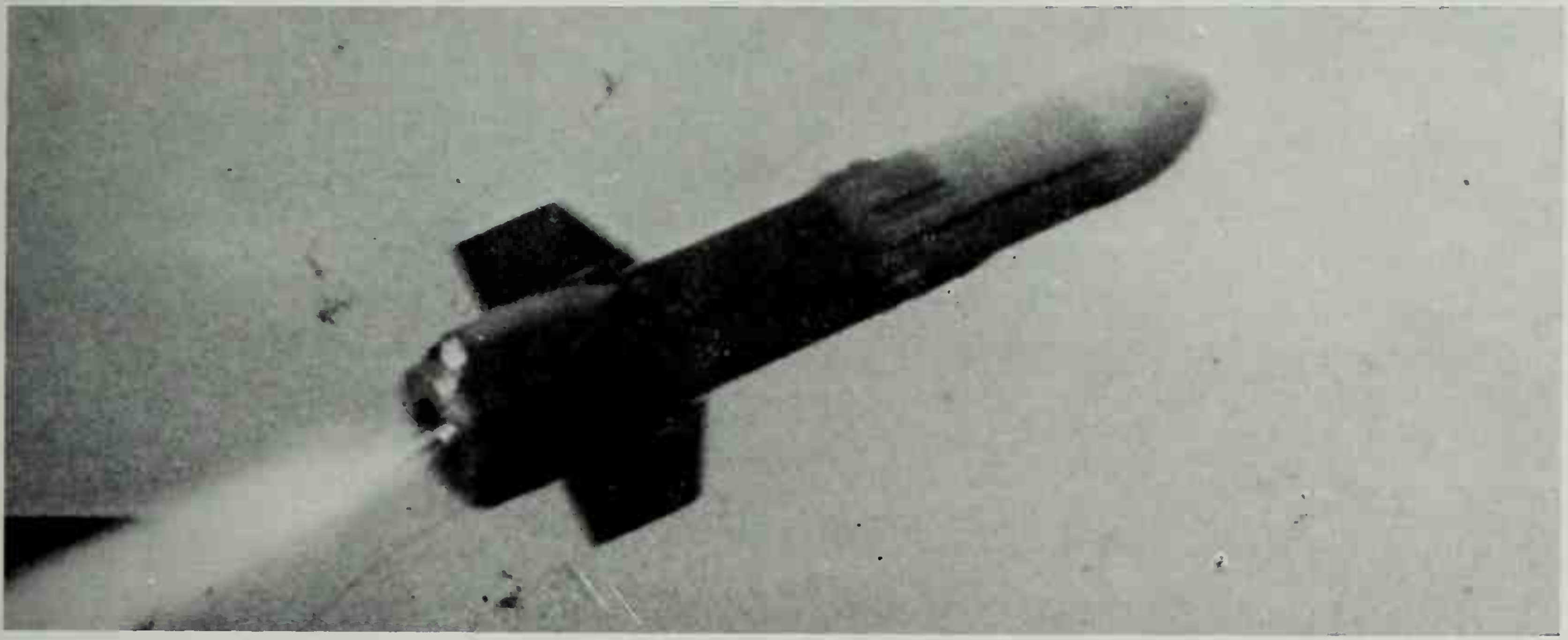
Swingfire separation sight

The FV438 Swingfire vehicle

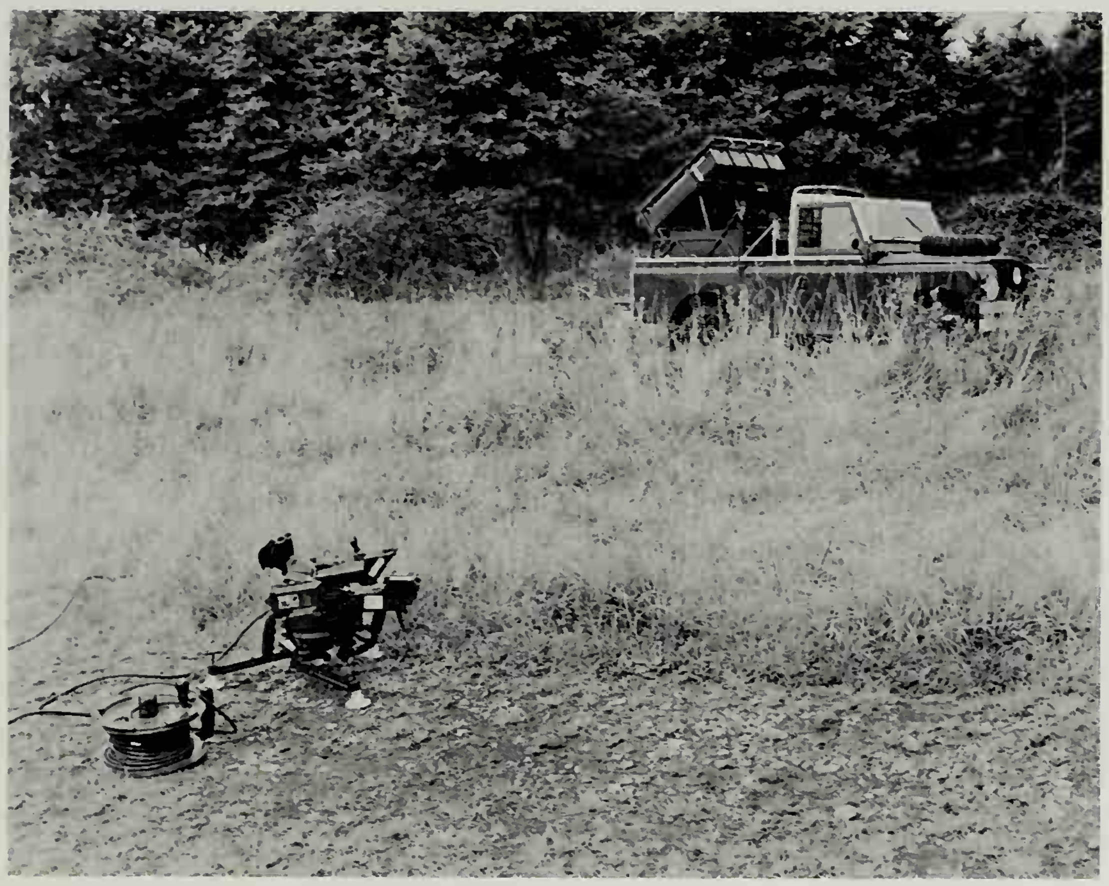
Swingfire

short- and long-range anti-tank wire-guided missile

Swingfire is a long-range wire-controlled anti-tank guided weapon system, easy to install in all types of fighting vehicles. It is automatically programmed on to the operator's line of sight, both in elevation and azimuth, allowing targets to be engaged from behind cover. This provides lightly armoured fighting vehicles with an outstanding lethality against heaviest armour. Swingfire has separation capability and can be fired and controlled by an operator some distance away from the launch vehicle. Due to its low launch acceleration and jetavator, it has a good short-range performance with an exceptionally wide cover. Swingfire has been designed and developed to be as robust as ordinary ammunition and requires no testing in the field. It is in full operational service with the British Army.



Swingfire fired from a FV438 vehicle



The Swingfire pallet, which enables the system to be operated from the ground under cover, also allows ready mounting on all types of vehicles, such as the long-wheelbase Land Rover and the Saracen armoured personnel carrier with the top removed

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Red Top

Red Top is a second-generation air-to-air guided weapon, developed out of the experience gained with Firestreak, and incorporating many of the scientific improvements in missile technology which came about during Firestreak development. Red Top is capable of 'all-round' attack and has enhanced altitude, speed, and range capabilities.

The basic design concept of Firestreak has been proved sound by rigorous testing and extensive trials under service conditions. Red Top, therefore, retains the configuration of four fixed wings and four moving rear control surfaces, with the design being further optimised to give operation over a very wide altitude and speed range. The infra-red guidance system has been further developed to allow target interception from virtually any direction.

Both complex and simple fire control systems can be supplied by Hawker Siddeley Dynamics for use in conjunction with Red Top.

The Red Top weapon system has been designed primarily as an integral part of the sophisticated United Kingdom defence system. However, the operational flexibility given by its all-round attack capability allows easy adaptation to suit the requirements of any defence environment.

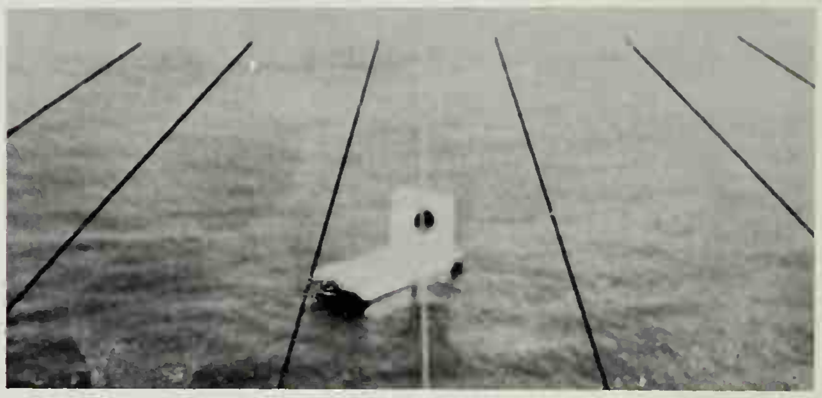
Martel

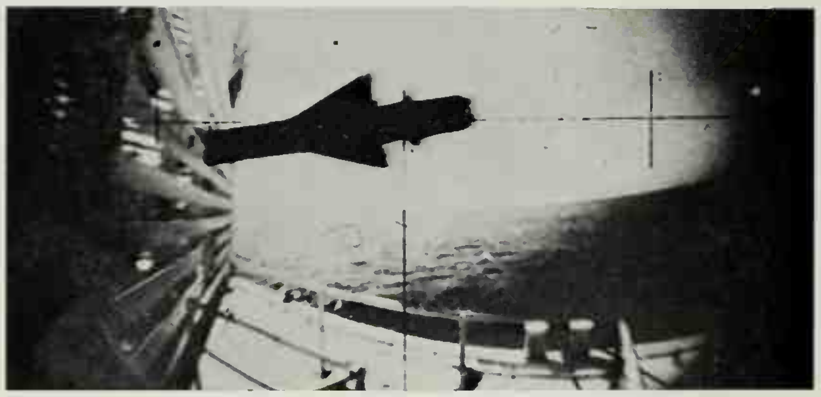
MARTEL—which is derived from Missile Anti-Radar and TELevision—is a new generation air-to-ground precision tactical strike missile, jointly designed and manufactured by SA des Engins Matra in France, and Hawker Siddeley Dynamics Limited in the United Kingdom, to meet the operational requirements of the two countries.

It is the first missile to offer real stand-off capability, giving a new element of surprise in attack and rendering the launching aircraft far less vulnerable. There are two versions of Martel: an anti-radar version having an all-weather attack capability and an ability to operate against multiple targets, and a television version which flies towards the target area automatically, the final impact on the target being effected by the weapons operator. Both missiles are designed to function in an ECM (electronic counter-measure) environment.

The Martel weapon support facilities can cope with either version, all aircraft-installed equipment being fitted on a role-change basis. The missile itself is interchangeable to suit mission requirements.

Martel is projected as the air-to-ground armament on several aircraft types. Other major companies associated with Martel are the Marconi Company, who provide the TV and radio link equipment which forms part of the guidance system in the television version, and Electronique Marcel Dassault who provide a part of the guidance system in the anti-radar version.



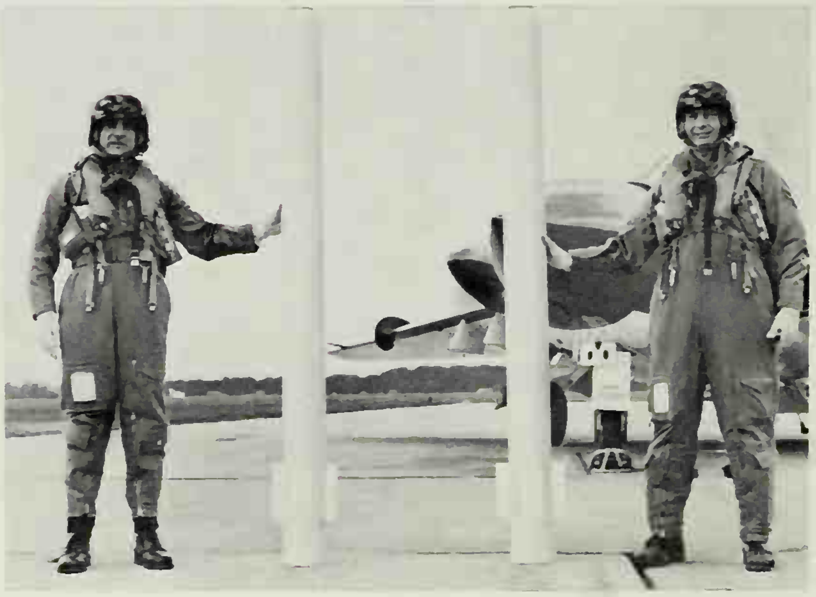


Taildog

An advanced new air-to-air weapon designed for close combat. In the dogfight the high manoeuvres of both target and fighter create a situation which cannot be met by existing air-to-air weapons and one in which guns rapidly lose their capability. The Taildog design ensures that it can operate down to a very short minimum range even with the target manoeuvring to its design limits. At the same time the maximum range is comparable to that of existing air-to-air sweapons.

Taildog uses an infra-red guidance system which is considered optimum in the close-combat situation. It achieves its high manoeuvre performance by the use of a new and unique navigation principle and a propulsion system employing thrust vector control.

Taildog is capable of installation on many types of aircraft, from the unsophisticated to the most complex, without requiring modifications to the aircraft structure. This is achieved by installing essential services in the missile launcher rather than in the aircraft itself.



Guided missiles

Red Top, Martel, Sea Dart and Ikara

Sea Dart

The advent of aircraft capable of speeds in excess of Mach 2 and the introduction of surface and air-launched missiles with a long-range stand-off capability posed a threat which required an area-defence missile system of very advanced technology to answer it.

The answer is Sea Dart, the most advanced shipborne weapon system in the world today.

Hawker Siddeley Dynamics Limited was responsible for the co-ordination of the design and development of Sea Dart and is the prime contractor for overseas sales. Other companies which form the Sea Dart consortium are:

GEC/AEI Ltd
EMI Electronics Ltd
Rolls-Royce Ltd
IMI Ltd
Ferranti Ltd
Vickers (Engineering Group) Ltd
The Sperry Gyroscope Division of Sperry Rand Ltd
Plessey Radar Ltd

A third-generation weapon, Sea Dart incorporates many new missile concepts, notably the semi-active homing head which enables a proportional navigation law to be used, and the ramjet engine which provides high sustained speed throughout the extensive propulsion envelope.

In its surface-to-air role the very small miss-distances achieved by Sea Dart during trials against manoeuvring targets at high or very low level prove that in operational use Sea Dart will achieve outstanding lethality.

The effect of Sea Dart in a surface-to-surface engagement can only be described as devastating.

Sea Dart is already being installed in the Type 82 destroyer HMS *Bristol*; it is also the choice of main armament for the Royal Navy's new Type 42 destroyers. System flexibility will also enable Sea Dart to be fitted in quite small frigates.

Ikara

The endurance, speed and diving capabilities of modern submarines are continually increasing. To meet this threat, surface ships must have long-range detection equipment linked to a weapon system capable of quick reaction and able to hit the enemy at long range before he can make his attack.

To be effective, the system must be capable of day and night operation, regardless of the weather conditions, and possess high reliability with the minimum of maintenance. To meet these exacting requirements the Australian Department of Supply and Department of the Navy have designed and developed the Ikara long-range anti-submarine weapon system.

This highly effective system is already at sea in ships of the Royal Australian Navy, and further units of the Australian fleet are being fitted with it.

In addition Ikara will shortly enter service in the Royal Navy in HMS *Bristol*, and selected frigates will be retro-fitted with the system modified to meet the special requirements of the Royal Navy.

Hawker Siddeley Dynamics Limited has an agreement with the Australian Department of Supply to act as representatives in the sale and installation of Ikara throughout Europe and selected overseas countries, and is able to advise on all aspects of the system. Hawker Siddeley Dynamics also provides a management service to the Ministry of Defence (Navy) to facilitate control and co-ordination of the RN Ikara programme. In addition, Hawker Siddeley Dynamics has been selected to lead the firms which will provide industrial support for the system once it is accepted into Royal Navy service.

The Ikara system

The concept of Ikara is the employment of a guided missile to deliver a homing torpedo to the target submarine. The missile is launched from a surface ship which uses a computer to work out the torpedo dropping position, from information fed into the computer from the ship's sonar and other sources of information on the submarine's position.

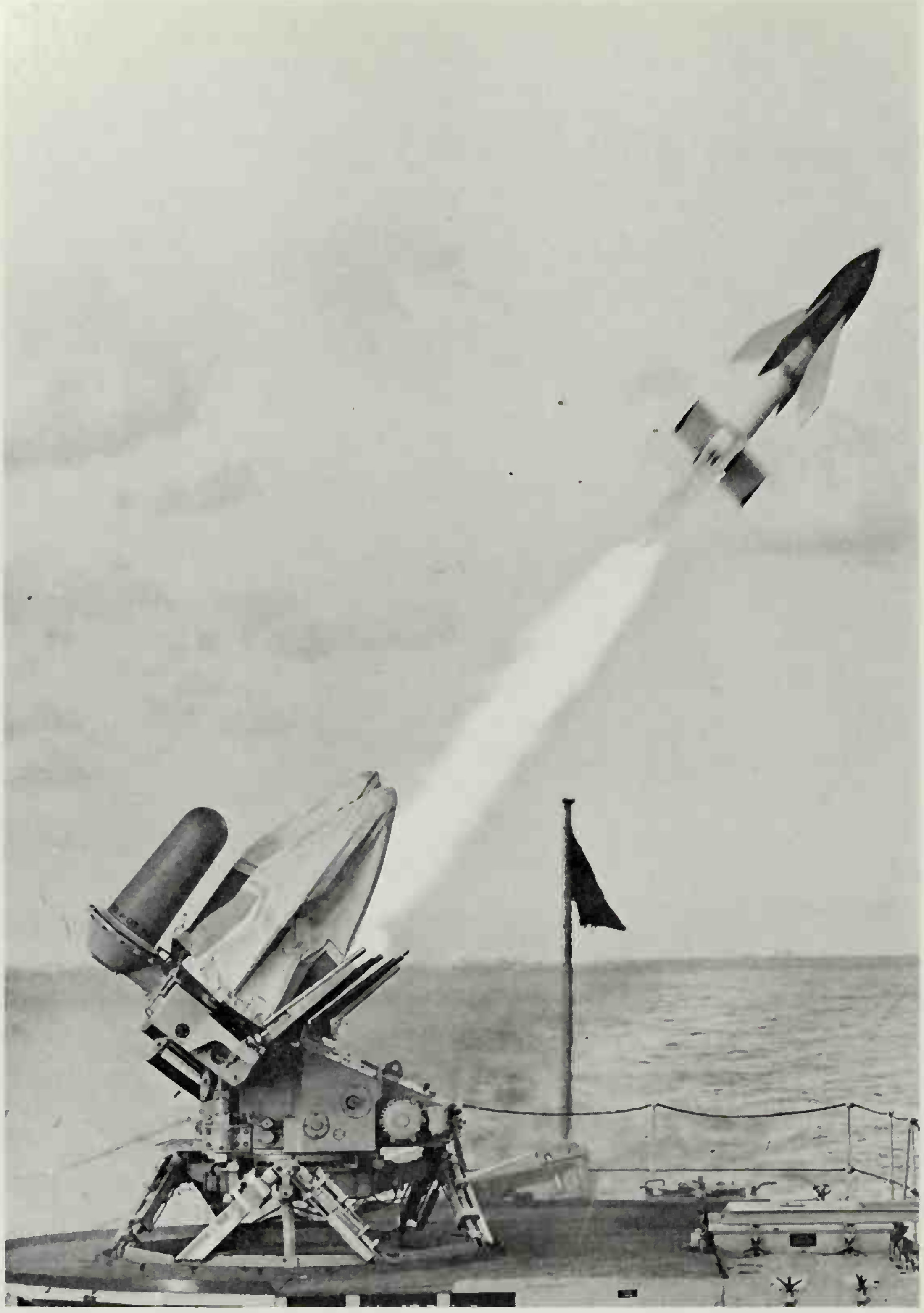
The guidance system ensures that the missile proceeds along its correct flight path to the dropping point, and can if necessary guide the missile to an up-dated dropping position, derived from target information fed into the computer after missile launch. After release from the Ikara missile, the special anti-submarine torpedo releases a parachute which controls its descent to the sea, where it relocates the target submarine and carries out a homing attack.

System capability

Ikara is capable of attacking enemy submarines out to the maximum range of the ship's sonar regardless of the weather conditions. In addition, an Ikara attack can be carried out on information received from another ship, or a helicopter equipped with dunking sonar. In this case target information is passed to the firing ship's computer, and an attack is carried out in the normal manner, even though the firing ship itself is not in contact with the target.

This mode of operating has been successfully proved in trials and considerably enhances the potential of Ikara.

HAWKER SIDDELEY DYNAMICS LIMITED
Manor Road, Hatfield, Hertfordshire, England
Telephone: Hatfield 62300 Telex: 22324



Seacat is in world-wide service as a close-range ship-to-air guided missile for anti-aircraft defence and is installed in more ships than any other weapon of its kind. It can also be used against surface targets.

It is Britain's export best-seller among guided weapons. Standard equipment with the Royal Navy, it has also been ordered by 14 overseas countries. Further orders are being negotiated.

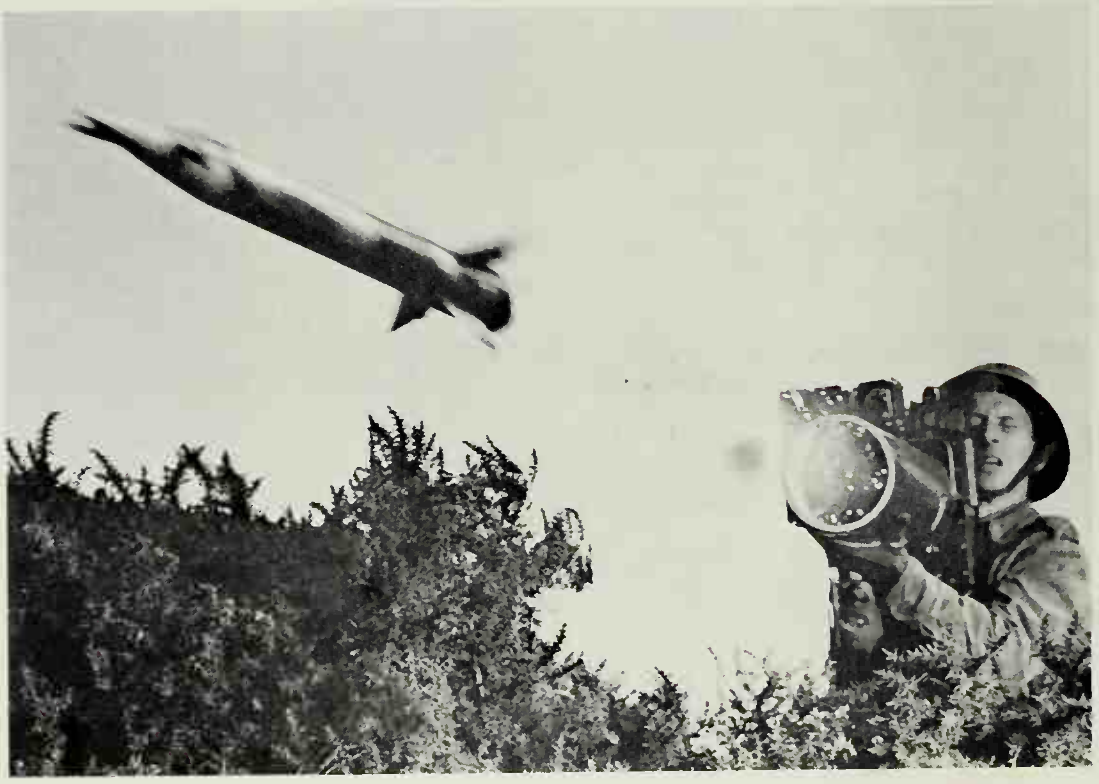
Seacat is simple, versatile and inexpensive. Its simplicity and accuracy are the result of the command-link guidance system on which it is based. An aimer tracks the launched missile through binoculars and by means of a thumb joystick issues radio commands which steer it to the target.

Its remarkable versatility enables the missile to be used with virtually any radar control system, and it has already been integrated with a number of director installations used by overseas navies. An automatic TV 'gathering' and control system for Seacat is now in production.

Blowpipe is a one-man supersonic anti-aircraft system based, like Shorts' Seacat and Tigercat, on the command-link guidance system. Its light weight gives it great mobility. It can be carried by a paratrooper, fired from the shoulder and airdropped in a multi-round pack. The complete system comprises only the missile itself, the canister which serves both as transport and launching platform, and the aiming unit attached to the canister, which contains all the ground equipment. The complete weapon system including one Blowpipe round weighs less than 18 kg (40 lb).

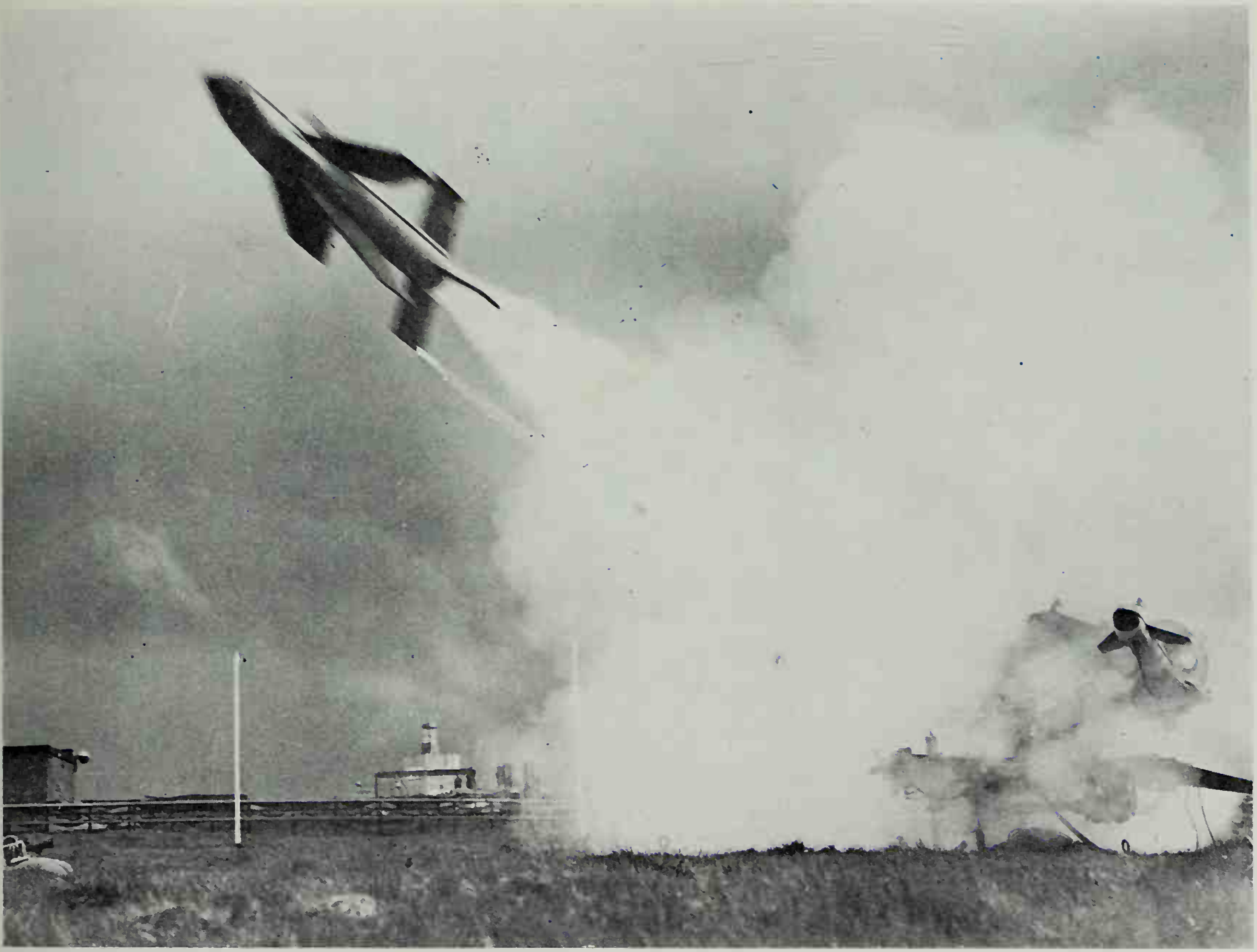
The missile can be fired from the ground or from a vehicle and can be readied for action in 10 seconds. Marine applications of Blowpipe are being developed and an air-launched role is proposed.

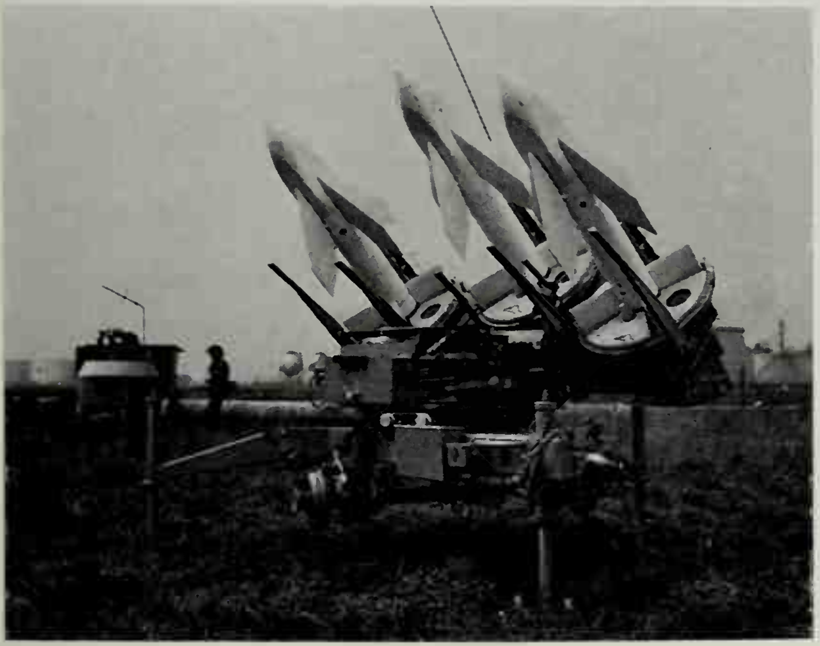
As with Seacat and Tigercat an optical sight and thumb joystick are used to guide the missile to its target.



Seacat, Tigercat, Blowpipe

guided missile systems





Tigercat, a ground-to-air version of Seacat, is in service with the RAF Regiment, the Imperial Iranian Air Force, the Jordanian Army and three other overseas customers. It employs the command-link guidance system perfected for Seacat and can be operated independently or combined with an existing gunnery system.

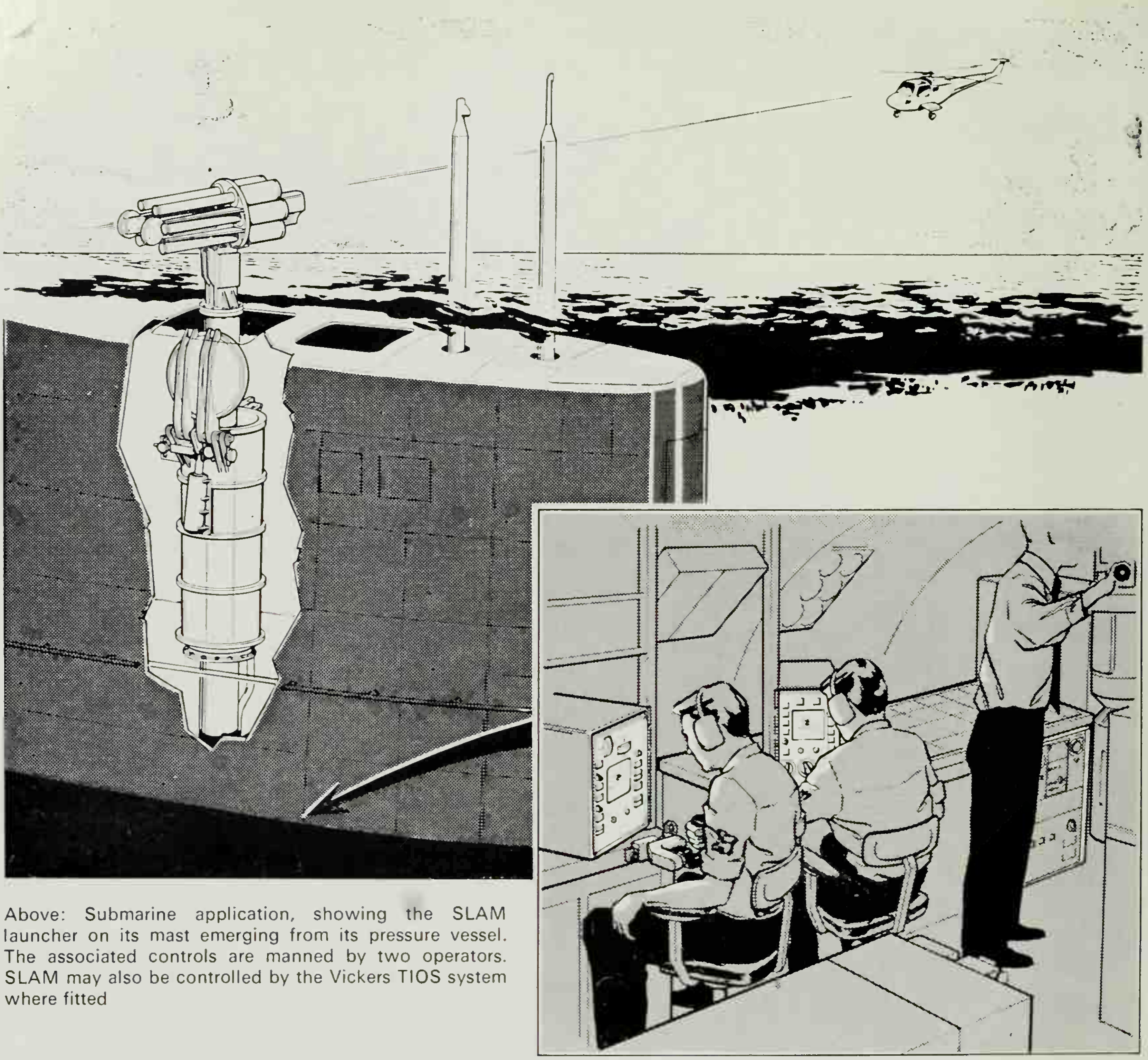
Basic equipment is carried on two trailers towed by Land Rovers or similar vehicles. One of these carries the three-round launcher, the other supports the aimer with his optical sight and launcher control gear.

The missile is identical with Seacat and its development and production have been speeded by Shorts' years of experience with the naval weapon. An air-launched version, Hellcat, to be fired from helicopters at surface targets, is now offered. Details of the Hellcat system are available on request.

SHORT BROTHERS & HARLAND LIMITED
Missile Systems Division
Montgomery Road, Castlereagh, Belfast, BT6 9HN, Northern Ireland
Telephone: Belfast 59271 Cables: Predivis Belfast Telex: 74688

SHORTS

1967
1968
1969
1970



Above: Submarine application, showing the SLAM launcher on its mast emerging from its pressure vessel. The associated controls are manned by two operators. SLAM may also be controlled by the Vickers TIOS system where fitted

Below: Preliminary firing of Blowpipe missile from the prototype SLAM mounted on its trials vehicle

SLAM

submarine or surface-launched air missile system

SLAM is being developed by Vickers to meet the need on submarines and light surface craft for an effective close-range armament against other surface vessels and helicopters. The system uses the Blowpipe missile, currently being developed by Short Brothers & Harland Ltd for the British armed services.

The system has been designed initially to match the Oberon-class submarine which, like many submarines today, undertakes operational roles where a surface attack capability would be valuable. SLAM enables the submarine to attack shallow-draft craft such as fast patrol boats as well as hovercraft and helicopters. Also, selective punishment may be inflicted on merchant ships.

A surface version of SLAM is also under development for hovercraft, fast patrol boats, and other coastal craft whose armament is limited.

System installation

The prototype system is currently undergoing trials, first on a land vehicle, then at sea. The launcher assembly shown carries six Blowpipe missiles clustered around a central electronics enclosure which contains part of the missile control equipment, television camera and gyro sub-system for launcher stabilisation. The missiles and their associated canisters form part of the standard Blowpipe system which has been developed by Short Brothers & Harland Ltd.

SLAM can be fitted in new construction submarines or retrospectively, without major re-working. A rapid-fit version is also available to meet particular operational needs. Fitment on surface craft will be possible without significant modification in most cases.

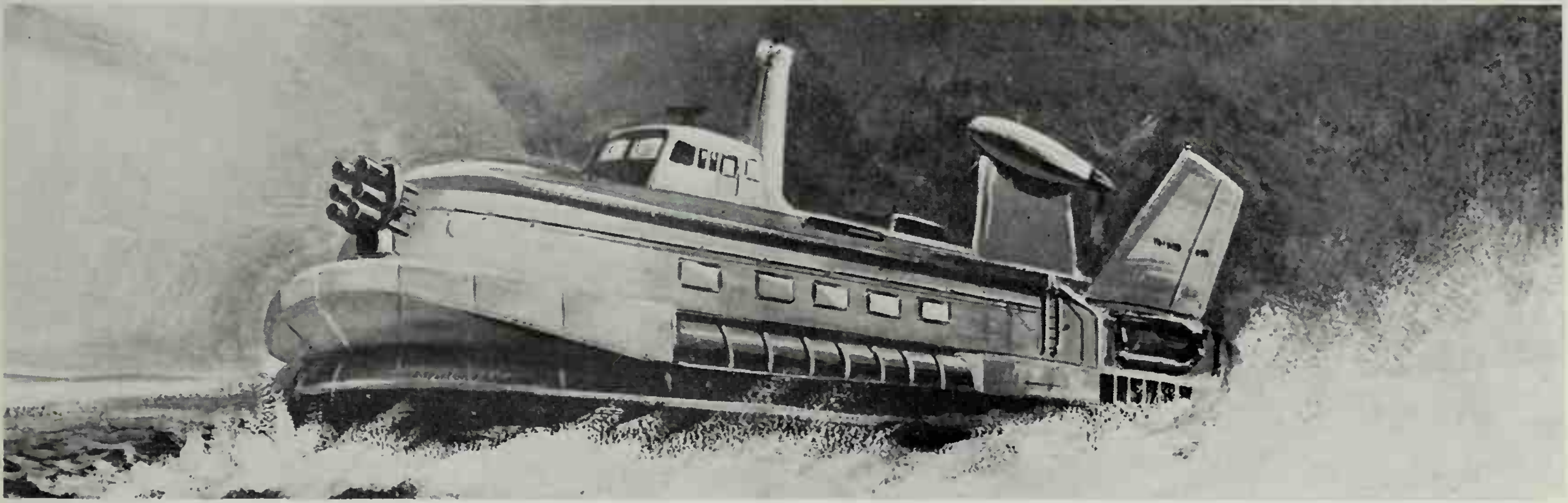
Submarine control-room equipment consists of missiles and launcher display panels, power supplies and control units for the television and launcher servo-control systems. Built-in test facilities are provided to enable routine servicing and rapid system checks to be carried out without the need for specialist personnel. Provision can be made for storing re-loads, their quantity and location depending on customer requirements.

Operation and simulation

For system operation and control two operators are used. A launcher operator controls the launcher system by means of a dual-motion controller which enables him to maintain the target in the screen centre, while the second operator selects, fires and tracks the missile to the target.

Target acquisition is accomplished by means of the search periscope, the launcher being automatically aligned with the target in azimuth.

On the prototype SLAM trials vehicle, missile firings can be simulated in conjunction with real target tracking and control of the launcher. Video-tape playback facilities are installed. Operators are trained on the prototype vehicle prior to carrying out full system trials of SLAM. Extra facilities such as simulation of own-ship movement and synthetically generated targets will be included later.



A hovercraft version of SLAM is under development, with installation planned for 1972

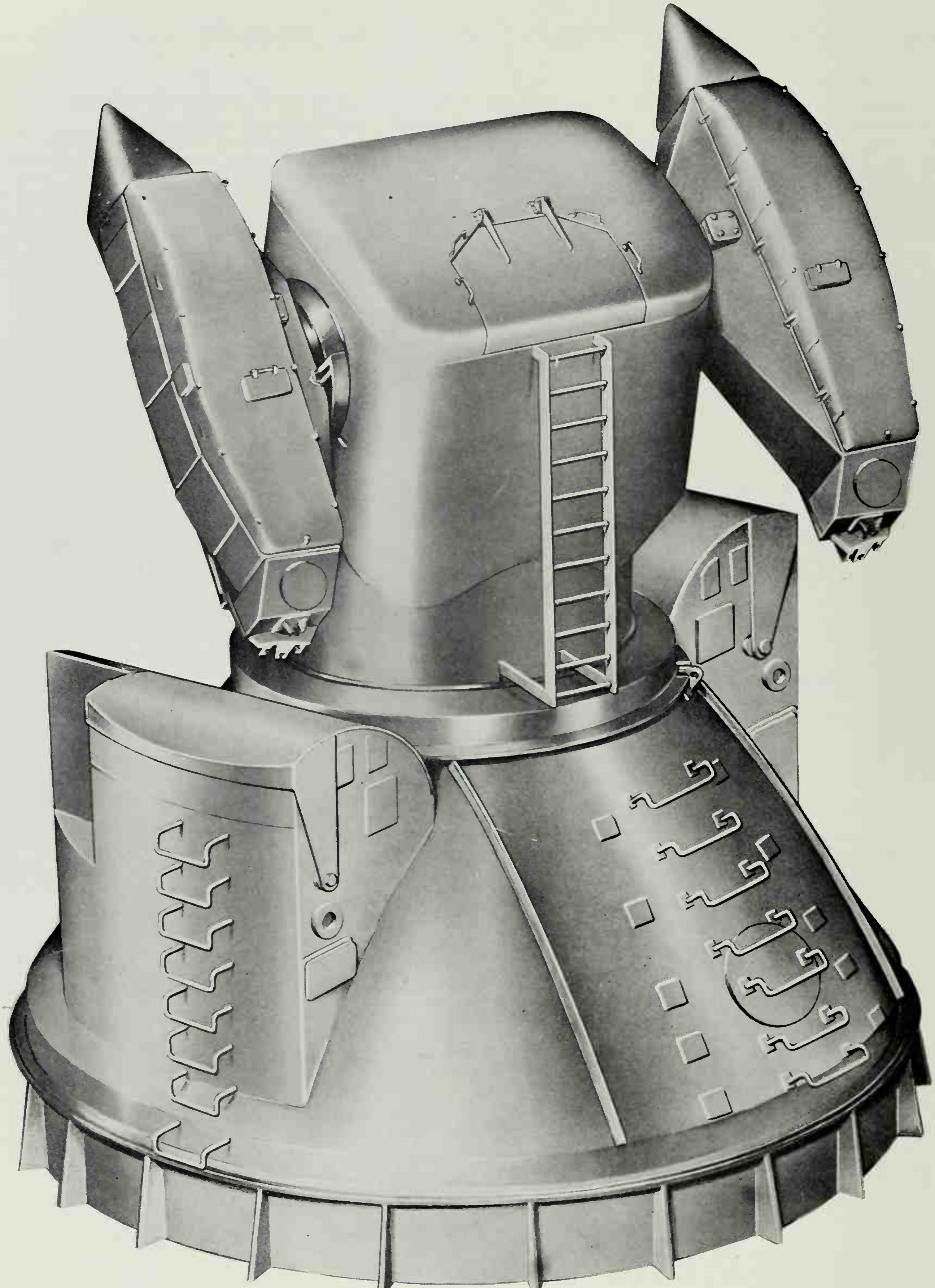
Specification

(Submarine-launched version)

Environment:
Wind up to 37 km/h (20 knots)
Wave impingement up to 1220 kg/m^2 (250 lb/ft^2)
Temperature 0°C to 55°C
Water pressure, without pressure vessel protection 7000 kg/m^2 (10 lb/in^2)
Sea state up to State 4
Shock: designed to meet shock levels laid down by the British Ministry of Defence (Navy)
Vibration: designed to meet Defence Specification DEF 133 Section N2
Ship motion: roll rates up to ±10° in 6 sec
Tracking rate: 10°/sec
Slewing rate: 40°/sec
Training angle: ±440°
Elevation angle: –10° to +90°
Accuracy: spatial pointing accuracy of ±1°

VICKERS SHIPBUILDING GROUP
Barrow Shipbuilding Works
PO Box 6, Barrow-in-Furness, Lancashire, England
Telephone: Barrow-in-Furness 20351 Cables: Vicarmsea Barrow-in-Furness
Telex: Barrow 6571

Vickers



Guided missile launchers

for Sea Dart and Seawolf

Vickers has been associated with armaments since the turn of the century and over this period, many designs (both naval and field equipment) have been developed, manufactured and proven in service.

In recent years, great technological advances have been made in armaments resulting in the sophisticated weaponry of today, with tracking and sighting performed by radar and guided missile launchers replacing the heavy gun.

We are in the forefront of modern naval armament design and construction, both for individual units and complete systems. Current projects include the Sea Dart and Seawolf launching systems, and the Vickers SLAM launching system for submarines and small surface craft (described elsewhere in this Catalogue).

In addition to the mechanical, hydraulic and pneumatic installations in these weapons systems, we also design and manufacture much of the electrical equipment used, including cabinets and control panels.

Design facilities are supported by experienced engineers and drawing office personnel for the preparation of manufacturing information and test documentation. Testing of components and complete weapon systems, with follow-up installation on board ship and setting to work, are some of the many services we have to offer.

Vickers launcher for Sea Dart

Vickers has designed and produced the launcher for the Hawker Siddeley Sea Dart guided missile, the gear for handling missiles in the missile magazine and for loading them on to the launcher. All this equipment is fully automatic, an essential feature if the weapon system is to be installed in small ships whose available accommodation limits the size of crew which can be carried. Automatic action is desirable also to give a high rate of fire to meet a heavy scale of attack.

The magazine equipment is so arranged that any selected missile can be loaded on to the launcher and, if not fired, can be returned to the magazine.

Automatic gear is also fitted for striking down new missiles into the magazine so that replenishment at sea can be achieved.

Vickers launcher for Seawolf

The British Aircraft Corporation's Seawolf is an all-weather surface-to-air guided missile for self-defence of ships against missile and aircraft attack by day or night.

The Vickers launcher for Seawolf is a lightweight unit in which preloaded missiles are protected for long periods against the severe conditions of a naval environment.

The launcher is suitable for all variants of the Seawolf guided weapon system, while in the longer term it can replace the Seacat launcher in ships already fitted with this system.

VICKERS LIMITED
Barrow Engineering Works
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Telex: 6597

Weapon electronic systems

guidance, safety and arming, fusing

Weapon guidance

Since 1950, when it was responsible for providing the guidance and test systems for the Royal Navy's Seaslug 1 and Seaslug 2 ship-to-air missile, the company has been active in the design, development and production of the guidance, fire control and test electronics for guided weapons. It is at present engaged on a considerable number of research and development contracts related to guidance problems and is also carrying out special studies into new weapon systems. In this area, it is able to work in association with other companies within the GEC-Marconi Electronics Group to provide complete missile guidance and control, drawing on Marconi Radar Systems Limited for target illumination and tactical control radars, and on Marconi-Elliott Avionic Systems Limited for electro-optical systems for automatic gathering and guidance.

Sea Dart

The Sea Dart missile, for which the company has designed and is providing the sophisticated guidance system, meets the threat to naval vessels of all forms of attack from the air that can be foreseen throughout the 1970s and 1980s. Its purpose is the interception of high- and low-level bombers, fighters, air- and surface-launched missiles, all capable of high speed and fast evasive manoeuvres. It is also designed to be effective against enemy surface units.

Differential tracking radar

A tracking radar has been designed to extend the capability of the BAC Rapier low-level air defence missile system. Rapier uses optical guidance, and the addition of the radar provides a blindfire capability, so that targets may be engaged during darkness and in poor visibility. Full mobility and air-transportability characteristics are maintained.

Missile development

The company is in a position to undertake the research and development of an air-to-air missile and to take part in joint ventures with European missile contractors. It has particularly powerful capabilities in the simulation of radar-guided weapons.

Automatic test equipment

Automatic test equipment, which is a fundamental requirement in the exacting field of missile production, has been provided for the Seaslug 1, Seaslug 2 and Sea Dart guided missiles. The automatic test equipment for the Sea Vixen airborne interception radar has been in production for a number of years, and the company has also been responsible for the test instrumentation and fire control systems for the Polaris missile.

Explosive systems

A safety-and-arming system ensures that the missile warhead is armed only when on course for the target and will be detonated at the required time and place by an appropriate type of fuse.

Safety-and-arming systems have been supplied for a wide range of guided weapons. Investigations into the most advanced techniques and the evaluation of prototypes in both on-ground and flight trials are continually in progress.

Fusing systems, employing radio and mechanical techniques, are being provided for a number of weapons. Recent activities include the development of a proximity fuse utilising capacitive techniques.

Sea Dart in action

Rapier in tactical position

A GEC-Marconi Electronics Company

MARCONI SPACE AND DEFENCE SYSTEMS LTD

Headquarters

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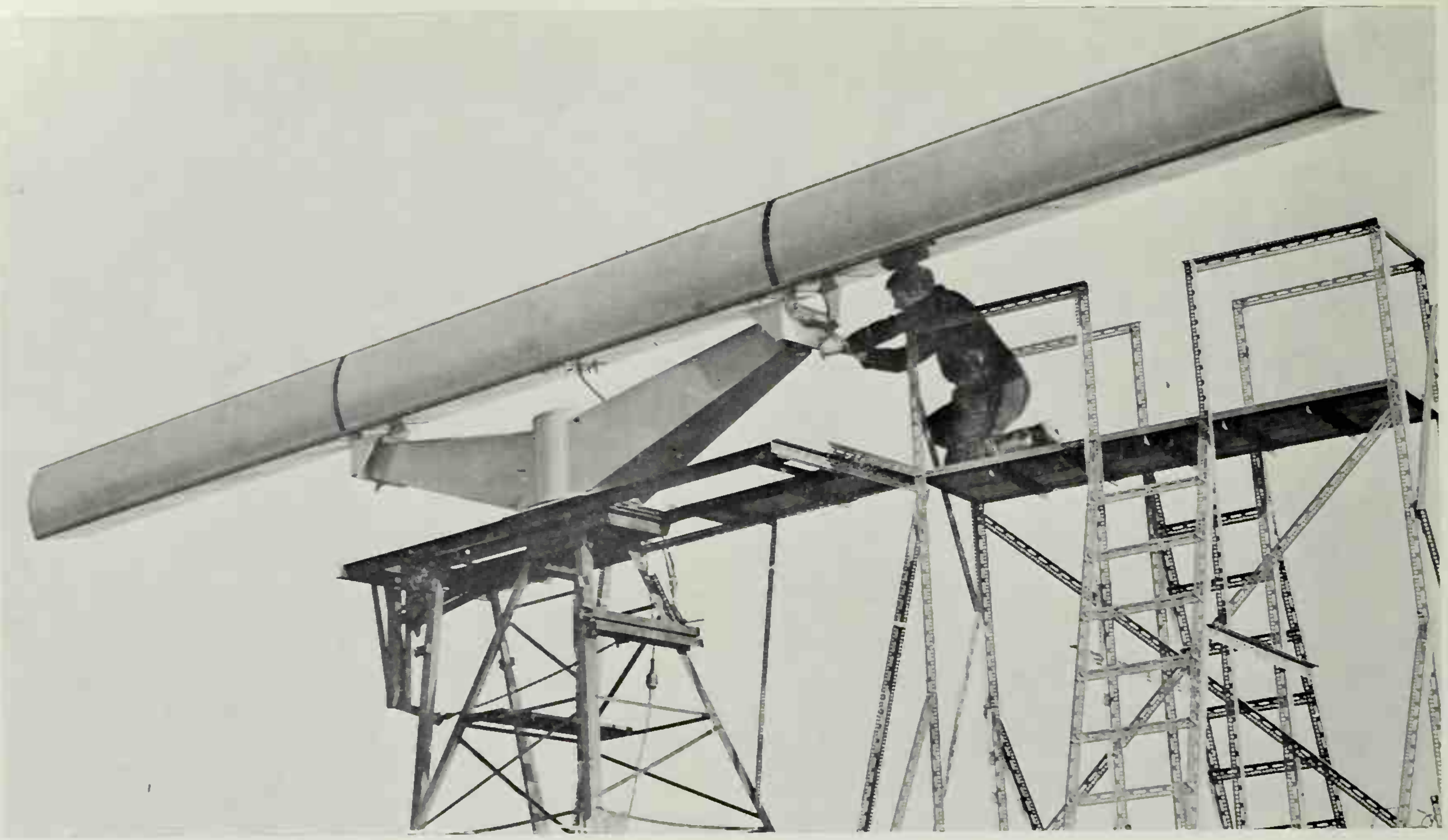
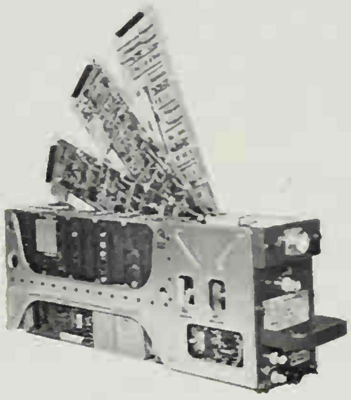
Section 23

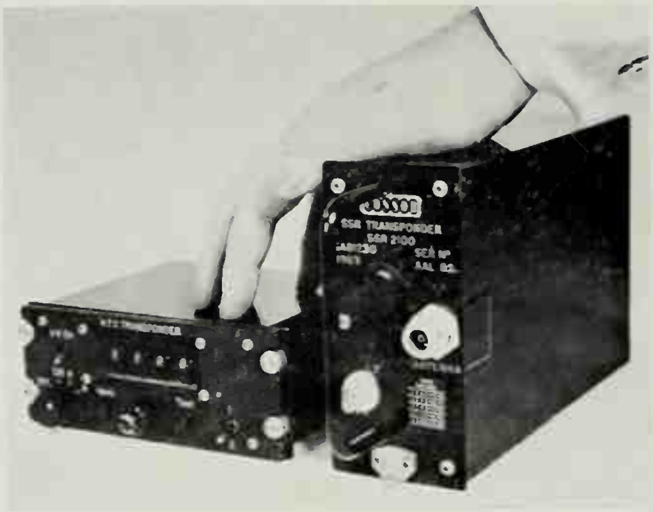
Air defence and air traffic radars



SSR 700 aerial on test rig

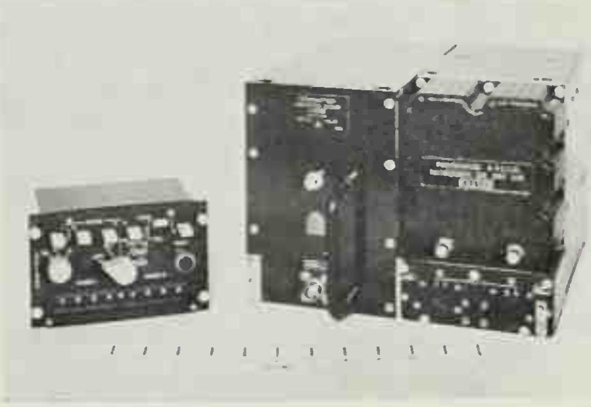


SSR 1600



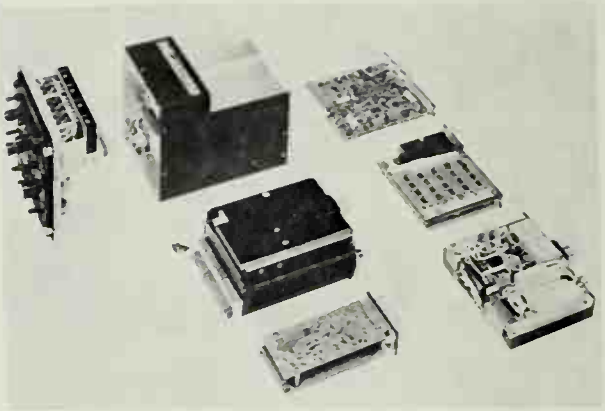
SSR 2100

SSR 2700

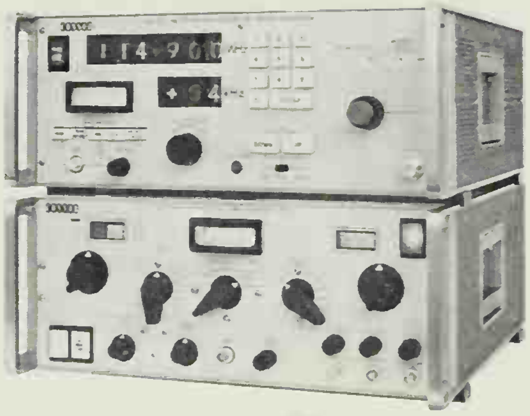


SSR 1520

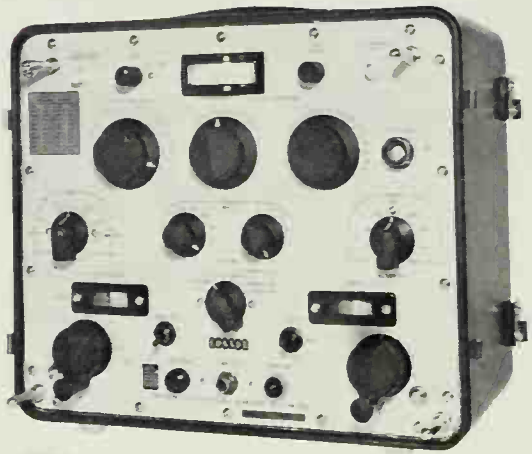
SSR 2900



SSR 2900—exploded view



CRM 511 and CRM 533



CRM 555

CRM 544

Secondary surveillance radar

for air traffic control and defence

A wide range of secondary surveillance radars (SSR), identification friend-or-foe radars (IFF), transponders and test equipment of many types is available from Cossor Electronics Limited. Brief details of some of the most important equipments are given here; full particulars are available from Cossor.

IFF/SSR surface equipment

SSR 700 Interrogator: meets ICAO Annexe 10 requirements. Civil/military modes: triple sector and aerial mode interlace. Solid-state transmitter/receiver employing integrated circuit techniques. Inetgral three-pulse SLS aerials available for mounting on suitable primary radars or, mounted on its own turning gear, for 'slaved' or autonomous operation. In quantity production. Customers include British Ministry of Technology, SHAPE Technical Centre, civil aviation authorities in Norway, Sweden and Austria.

SSR 750 Interrogator: based on the SSR 700, but with additional facilities for air defence stations. Large order in production for British air defence radar systems.

IFF 800 Interrogator: incorporates many basic SSR 700 sub-units but packaged for shipborne use. Ordered in large quantities by the British, New Zealand and Indian Navies.

SSR 700 transmitter/receivers on final inspection

IFF for missile systems

IFF for Thunderbird: designed to meet the British Army requirements for range, ruggedness and reliability in the Thunderbird system.

IFF for Rapier: ruggedised equipment designed to rotate with the search and acquisition radar.

IFF for Blowpipe: this equipment employs the latest micro-miniaturisation techniques to achieve an all-up weight of 2·025 kg (4·5 lb).

Airborne civil transponders

SSR 1600: transistorised equipment designed to ARINC 532D. The first transponder offered with guaranteed mean time between faults. Supplied in large quantity to the major British airlines and the Royal Air Force.

SSR 2100: the world's first micro-miniaturised airline transponder. This equipment employs silicon integrated circuit techniques. The total weight of transponder and control unit is 2·565 kg (5·7 lb). This model has been sold in quantity to British European Airways and to the British Government.

SSR 2700: designed to ARINC 572 and includes integrity monitoring and antenna isolation. Weight 4·5 kg (10 lb). Will shortly be in production.

SSR 1500/1520: Transistorised high-performance transponder with civil and military modes. Operates between −55°C and +125°C and up to 30 000 m (100 000 ft). This is the standard transponder used by British and several overseas military services.

SSR 2900: advanced micro-miniaturisation techniques are employed. The transponder and control unit are integrated into a single package, thereby eliminating interconnecting cableforms, simplifying cockpit installation and further enhancing reliability.

SSR 3000: similar to SSR 2900 but has a separate control unit for use when the transponder cannot be accommodated in the cockpit.

Avionics test equipment

CRM 544: an all-solid-state, waterproof transponder ramp test equipment. Standard equipment for many major airlines and military services.

CRM 555: transistorised, battery-operated equipment for accurate checking of airborne systems from the flight deck. The CRM 555 checks the localiser, glide path, VOR and marker receivers and the auto-pilot airlines. It has sold especially well in the USA

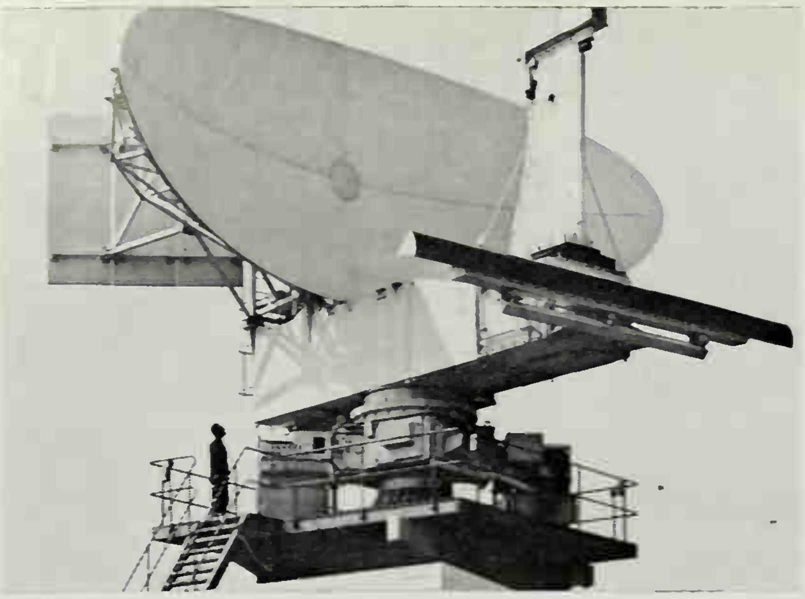
CRM 558: a complementary development of the CRM 555. The high accuracy and stability makes the CRM 588 eminently suitable for testing ILS systems to lower weather minima/autoland requirements. The CRM 588 is now in production and the first orders are already in execution.

CRM 511: a high-accuracy equipment for maintenance and production testing of the airborne systems for ILS marker, ILS localiser, ILS glidepath and VOR.

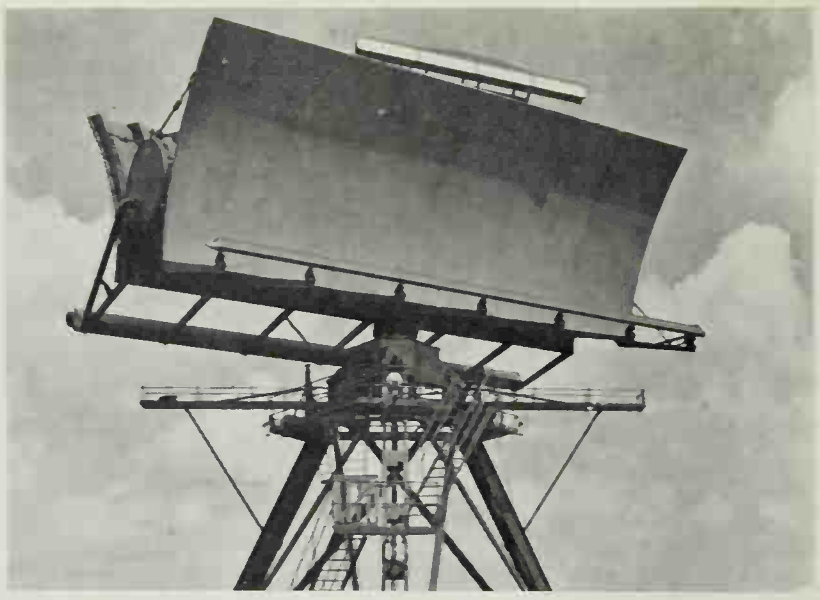
CRM 533: an advanced equipment designed for use in conjunction with CRM 511 for testing airborne systems. The CRM 533 is about to enter production.

COSSOR ELECTRONICS LIMITED
Avionics and Surface Electronics Division
The Pinnacles, Harlow, Essex, England
Telephone: Harlow 26862   Cables: Cossor Harlow   Telex: 81228

COSSOR

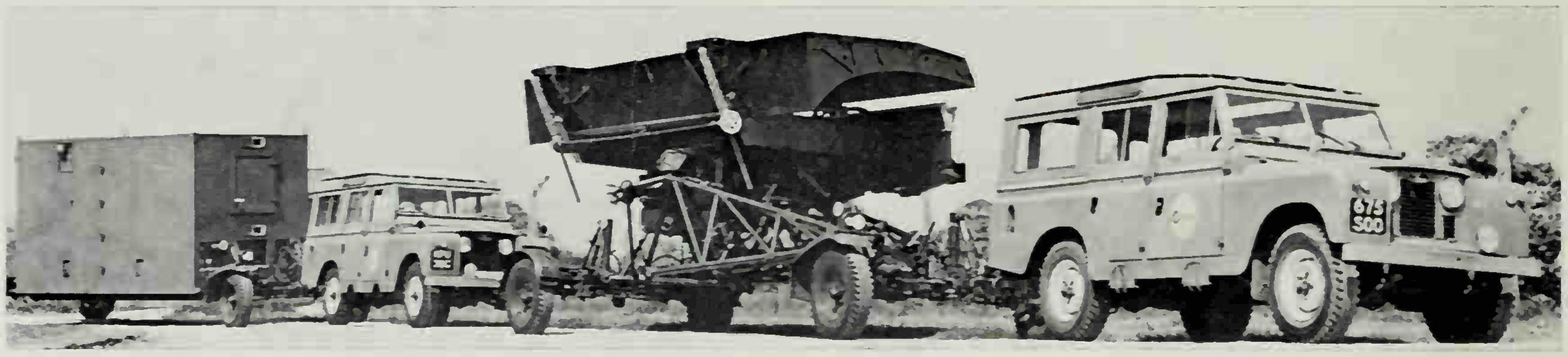


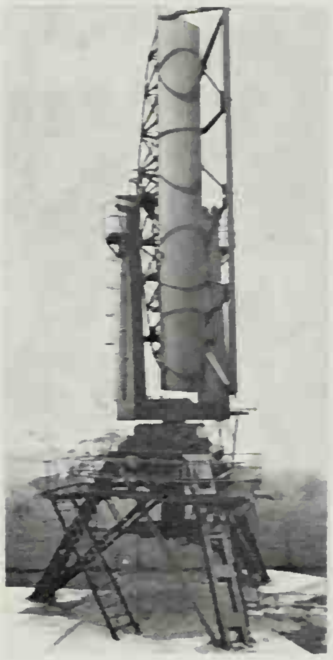
Above: The 40 series 10 cm stacked-beam volumetric radar



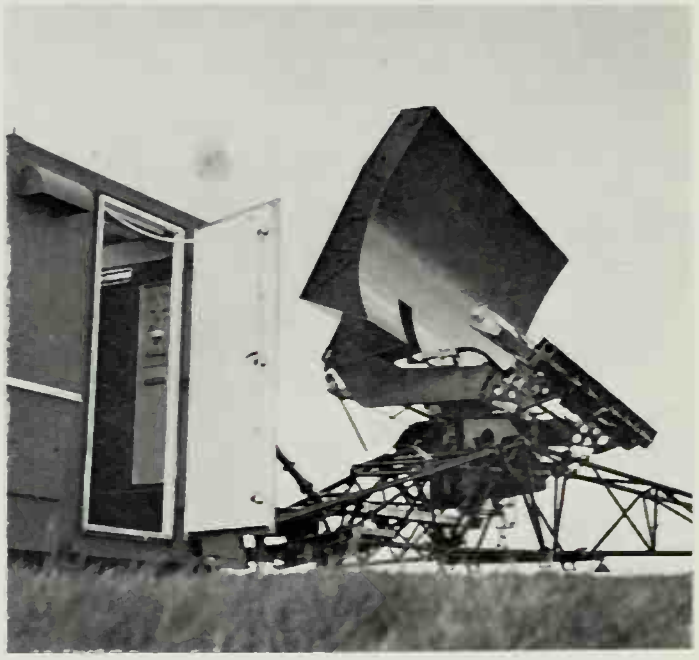
Above: Aerial system of Type S 247 surveillance radar

Below: 10 cm transportable surveillance equipment ready for towing

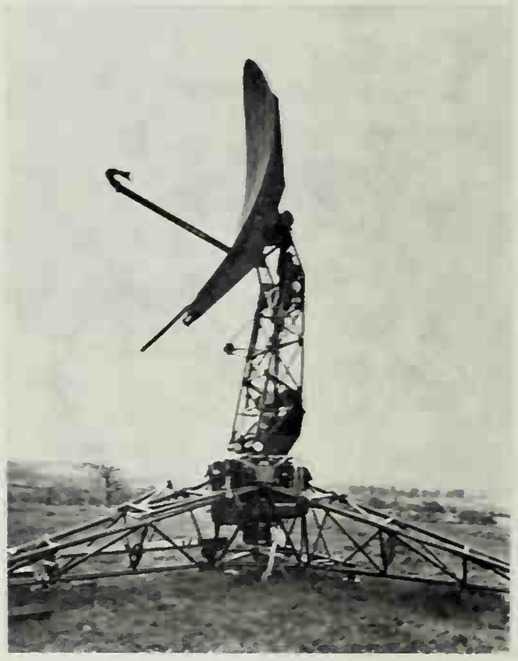




Above: 10 cm static heightfinder aerial

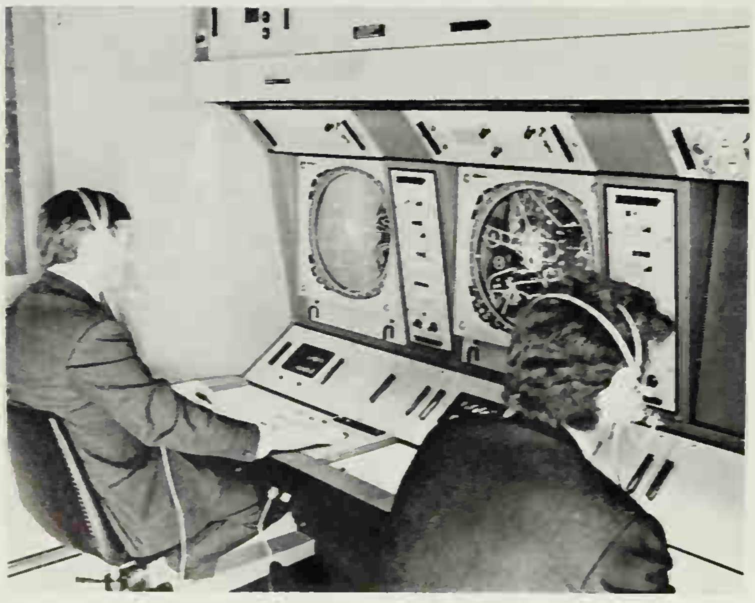


Above: 23 cm transportable surveillance aerial deployed



Above: 5·5 cm transportable heightfinder aerial deployed

Below: display position in a manual operations cabin



Below: section of a data-processing cabin

Air defence radar

S600 series, 40 series and digital simulators

Marconi Radar Systems Limited embraces the full radar system capability of Marconi, Elliott and AEI in air defence, air traffic control and shipborne defence applications. The range of systems includes every type of equipment in the radar field: primary and secondary radar heads from large stacked-beam 3-D radars through air-transportable and mobile systems to a one-man-pack radar weighing a few pounds.

S600 series air-defence radar

The S600 series is a family of compatible radar units which can be built up to form various systems capable of meeting almost any defence or air traffic control requirement. The modular design concept of a range of radar equipment provides a much higher degree of flexibility and cost-effectiveness than has previously been possible. Special emphasis has been placed on reliability, compactness and ease of operation, setting new standards in these areas.

The S600 series was evolved following an intensive study of radar developments and assessment of operational requirements for the next decade. The overriding design considerations are:

Suitability to both static and transportable roles
Good height accuracy
Intrinsic simplicity
Minimum antenna area
Frequency flexibility
Excellent clutter suppression.

The modular concept of the S600 series is ideally suited to the requirements of modern defence forces. For air defence applications there is a range of separate surveillance and heightfinding radars which together with display and data-handling elements provide basic sub-systems which are capable of operating in complete isolation and, when the situation demands, can also be combined to form, or reinforce, an air defence system. These systems, ranging from simple basic facilities to complex networks, can be readily extended as required and the individual elements can be rearranged into different configurations without any loss of compatibility. Air defence applications of the S600 series include, early warning and air surveillance, gap filling, ground controlled interception (GCI), coast watching, weapon control (SAM) and military air traffic control.

The use of modular construction and the high degree of standardisation throughout the S600 series has minimised the overall capital cost of establishing a radar system to meet individual requirements and the overall cost-effectiveness is unequalled when a comparison is made of providing and sustaining, in the long term, the system to meet a particular requirement.

The mobility of the transportable elements offers complete freedom in the choice of operational sites with the ability to redeploy rapidly to meet changing tactical situations. The transportable elements comprise aerial assemblies, which fold easily and quickly for transportation, and standard cabins, housing transmitter/receivers, display, data-handling and communications equipment, which can be lifted by helicopter, carried in transport aircraft such as the C130 or towed by a light vehicle such as a Land Rover.

For static installations there is a complete range of aerials which can be mounted on either gantries or plinths. The electronics units are the same as those used for transportable systems and their compactness leads to great space savings. An S600 static system is highly adaptable in that basic systems can be extended quite readily to take advantage of frequency diversity and to improve range performance.

The strength of the S600 concept lies in the interchangeability of each and compatibility of all elements, which makes it possible to start with the nucleus of a simple radar and built up to whatever configuration is required. The standardisation of main components simplifies the problem of support in the form of spares and maintenance.

In the transportable role, there is the added facility of all, or part, being deployed to meet particular contingencies. It is possible to build up the control facilities in a tactical situation from the simplest surveillance component up to the full strike and intercept or control facility which will operate when supporting services and communications have been built up.

Basic elements of the S600 series include:

10 and 23 cm transportable/static surveillance aerials
10 and 23 cm static surveillance aerials
5·5 cm transportable/static heightfinder aerial
10 cm static heightfinder aerial
Electronics cabins for transportable/static surveillance radars
Electronics cabins for transportable/static heightfinder radars
Manual operations cabins for transportable/static radar systems
Computer-assisted operations cabins for transportable/static radar systems
Data-processing cabins for transportable/static radar systems
Accessories for transportable/static radar systems including power plant, mounting pallets, air-conditioning units and running gear
Transmitter/receivers, signal processing systems, radar displays, data displays, real-time computers, video map generators, radar links and communications systems

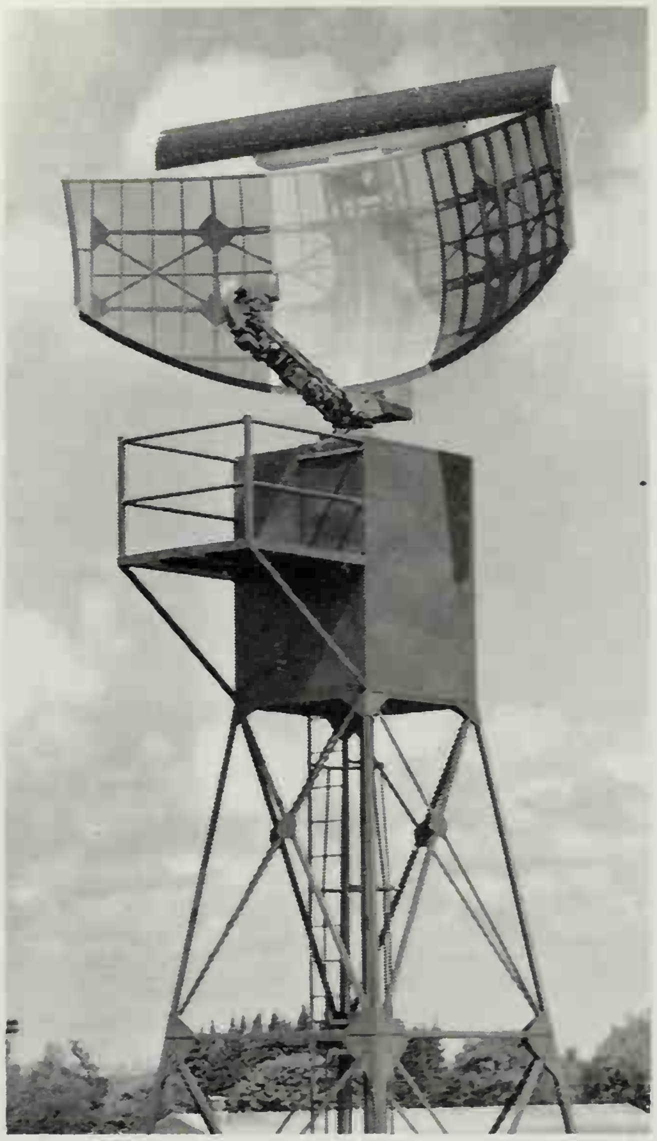
40 series radar

The 40 series radar, an advanced volumetric radar employing the stacked-beam principle, has been designed to meet the needs of the most modern air defence systems. It provides coverage from near ground-level to over 30 500 m (100 500 ft) in all weather conditions.

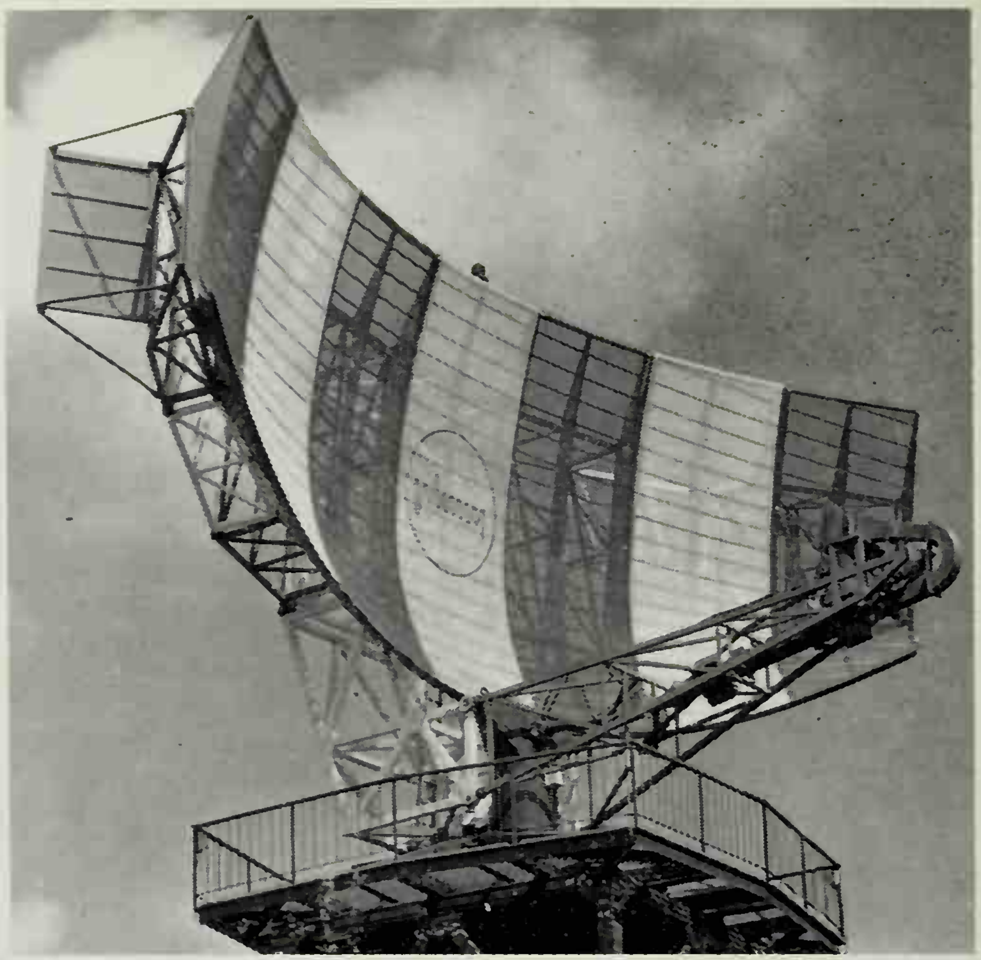
Digital radar simulators

Marconi Radar Systems Limited has complete systems capability in the field of simulation. It is practical and economical to employ simulation techniques to satisfy 80 per cent of training requirements, for either individual units or defence systems at national level. Simulation also provides an excellent method of assessing equipment efficiency and cost-effectiveness.

A GEC-Marconi Electronics Company
MARCONI RADAR SYSTEMS LIMITED
Crompton Works, Chelmsford, Essex, England
Telephone: Chelmsford 67111   Cables: Marstor Chelmsford   Telex: 99108

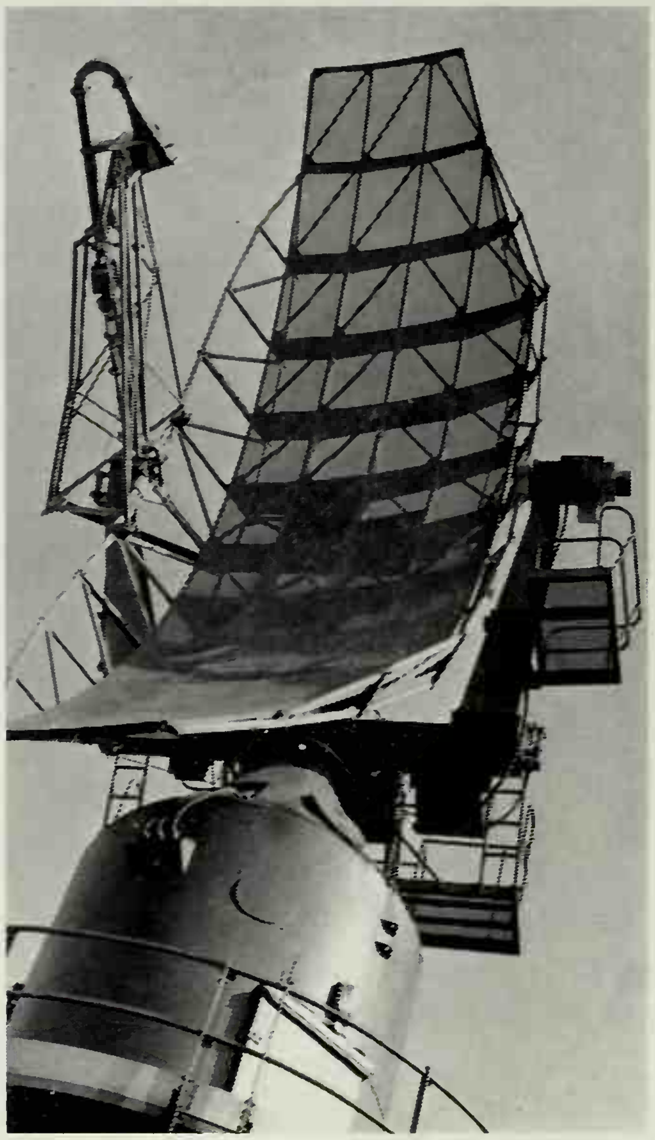


The AR-1 is designed for general-purpose air surveillance to a range of 150 km. The equipment is ideal for fighter recovery and gapfilling roles in addition to which its outstandingly good low-level cover suits it for low-level surveillance and missile target acquisition

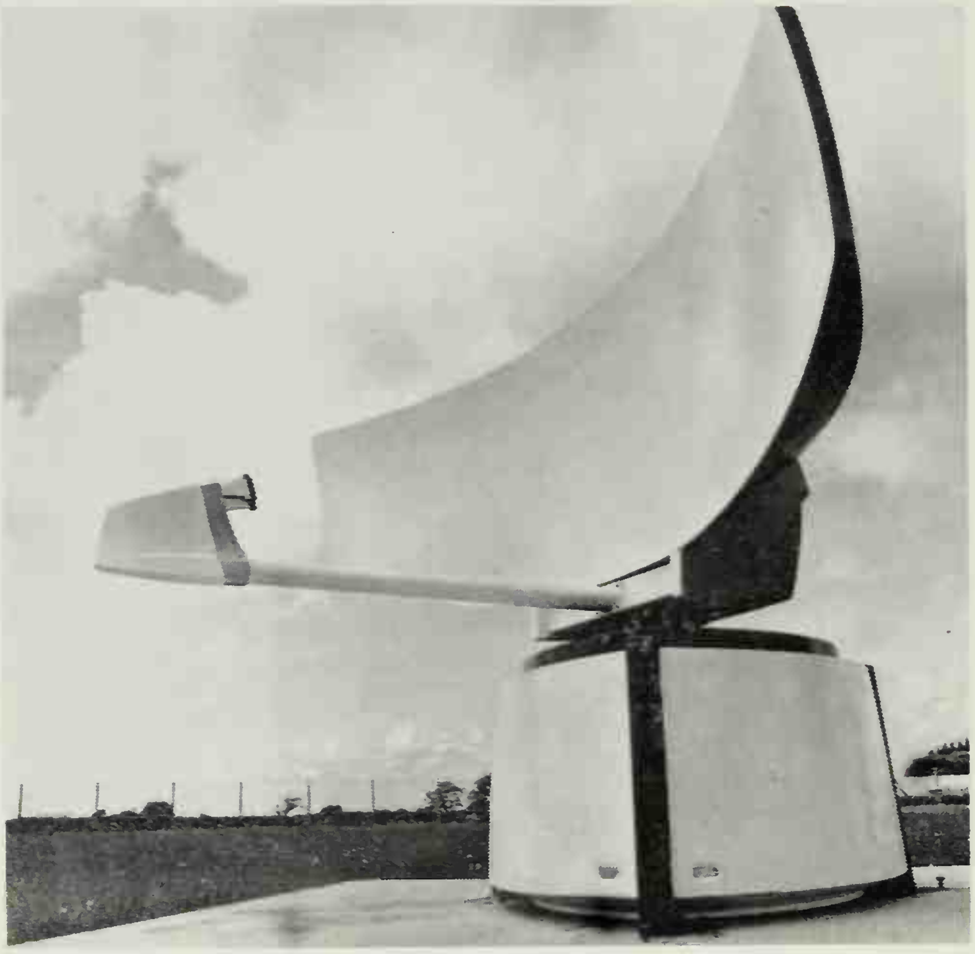


The Plessey AR-5 air defence radar combines a range of up to 550 km for long-range surveillance with exceptional discrimination at short ranges

The high-power S-band Plessey HF-200 height-finding radar offers high accuracy over long ranges. It is compatible with the AR-5 and can be integrated with other radar systems



Surveillance of the local area and high-accuracy approach control are provided by the very compact Plessey ACR-430, making it ideal for smaller airfields



Air defence radar

for surveillance and control

Plessey Type AR-1

The Plessey AR-1 is a highly versatile medium-range air surveillance radar, with coverage of over 150 km on Canberra aircraft and providing outstandingly good low cover. The equipment, over 100 of which have now been sold, is a dual diversity 650 kW S-band radar and is available with full eccm (electronic counter counter measures) signal processing facilities.

The equipment has been ordered by, or is in use with, some 16 armed services for such diverse roles as fighter recovery, surveillance element of ground control approach, forward low-level surveillance, range surveillance, coastal surveillance and missile target acquisition.

The naval version of AR-1, the AWS-1, is in widespread use as a shipborne air warning and target acquisition radar.

Versatility of operation, pre-designed installation, ease of maintenance and low capital cost coupled with excellent operational performance and high reliability have contributed to the success of the AR-1 which is available in both static and mobile configurations.

Specification
Radiation frequency: two spot frequencies in the band 2750–3050 MHz
Polarisation: variable from linear through elliptical to circular
Aerial gain: 31 dB relative to isotropic radiator
Aperture: horizontal 488 cm (16 ft), vertical 198 cm (6½ ft)
Horizontal beam width: 1·5° to half-power points
Rotation rate: 15 rev/min clockwise
Transmitter magnetron peak power: 650 kW nominal per transmitter (2)
Pulse length: 1 microsecond
Pulse recurrence frequency: 700 pulses per second
Receiver noise factor: not worse than 6 dB
Intermediate frequency: 30 MHz
Displays: two fixed-coil units standard, up to two more optional
Presentation: plan position display with one interscan line
Data presented: radar video, range markers and interscan line; video map and IFF/SSR optional
Range scales: 12·5, 25, 50 and 100 nm (23, 45 90 and 180 km)

Plessey Type AR-5

The Plessey AR-5 is a relatively simple, low-cost long-range air defence radar with coverage extending up to 550 km.

The equipment, operating on 23 cm (L-band), employs 2 MW transmitters in dual frequency diversity and has full eccm performance. Solid-state techniques are used throughout within a framework of accepted and well-proved radar techniques. Accuracy and discrimination exceed the requirements for GCI (ground control interception) purposes, and data rates up to 15 rev/min can be provided.

The AR-5, which has been ordered by the British and many overseas governments, can be supplied with data handling systems of any desired capacity or complexity.

Specification
Radiation frequencies: frequencies in selectable band 1250–1365 MHz
Polarisation: variable from linear through elliptical to circular
Aerial gain: 36 dB relative to isotropic radiator
Beam width: horizontal 1·2°, vertical 3·5° shaped to 40°
Rotation rate: single or dual speed in range 4–15 rev/min
Transmitter magnetron (tunable) power output: 2 MW peak
Pulse length: 2·0 μsec min, 5·0 μsec max
Pulse recurrence frequency: 250/sec min, 750/sec max
Receiver noise factor: 3·5 dB
Intermediate frequency: 30 MHz, crystal-controlled AFC
Characteristics: linear, log, Dicke-fix, log pulse length discriminator gated by Dicke-fix
Moving target indicator: digital 3-pulse, double cancellation with velocity feedback
Cancellation: rack 41·5 dB
Sub-clutter visibility: up to 30 dB, dependent on selected parameter
Video integration: digital

Plessey HF-200

The Plessey HF-200 is a high power (2·5 MW) S-band heightfinding radar providing high accuracy and high data rate. The equipment is the ideal complement to the AR-5 air defence radar and is in widespread use with the British and overseas governments.

Both nutation and slewing are hydraulically controlled and the vertical angle of sweep is automatically coupled with the operating range selected. These features provide maximum accuracy and data rate. Azication programming and volumetric scan facilities are available.

The equipment has full eccm signal processing facilities and can be integrated into any radar system.

Specification
Polarisation: variable from linear through elliptical to circular
Vertical beamwidth: < 50 minutes of arc at –3 dB points
Horizontal beamwidth: 2·5° ±0·5° at –3 dB points
Gain: >40 dB re isotropic radiator
Maximum nodding angle: –3° to +33°
Nodding rate: 20 sweeps/min for max nod angle (36°); 60 sweeps/min for min nod angle (8°)
Variation of nodding angle: automatically as a function of range, giving an increased data rate on long-range targets
Max slewing speed: 6 rev/min in either direction

Plessey Type ACR-430

The Plessey ACR-430 is a low-cost, high-performance radar providing both precision azimuth approach facilities and local area surveillance for fighter recovery and GCA purposes at advanced air bases and airfields where costly complex GCA systems are not called for.

Operating on 3 cm (X-band), the ACR-430 combines high discrimination and resolution with small aerial dimensions. The duplicated electronic equipment uses solid-state techniques throughout.

Specification
Maximum range: 32 nm (60 km)
Horizontal beamwidth: not greater than 0·65°
Vertical beamwidth: control 2·5°, surveillance 2·5° shaped to cosecant^2 25°
Pulse length: 0·5 μS 1000 pps; 0·1 μS 1800 pps
Range resolution: 20 metres short pulse; 80 metres long pulse
Range accuracy: 1% of maximum range selected
Receiver noise factor: better than 10 dB
Tuning: automatic frequency control and manual
Characteristics: linear, logarithmic, wideband limiting, fast time constant switchable with each output
Aerial rotation rate: 20 or 40 rev/min selected at the control panel
Aerial tilt: 0° to +18° adjustable from radar control panel

Plessey air defence systems and naval radars are described elsewhere in this Catalogue

PLESSEY RADAR LIMITED
Addlestone, Weybridge, Surrey, England
Telephone: Weybridge 47282 Cables: Plessrad Weybridge Telex: 262329

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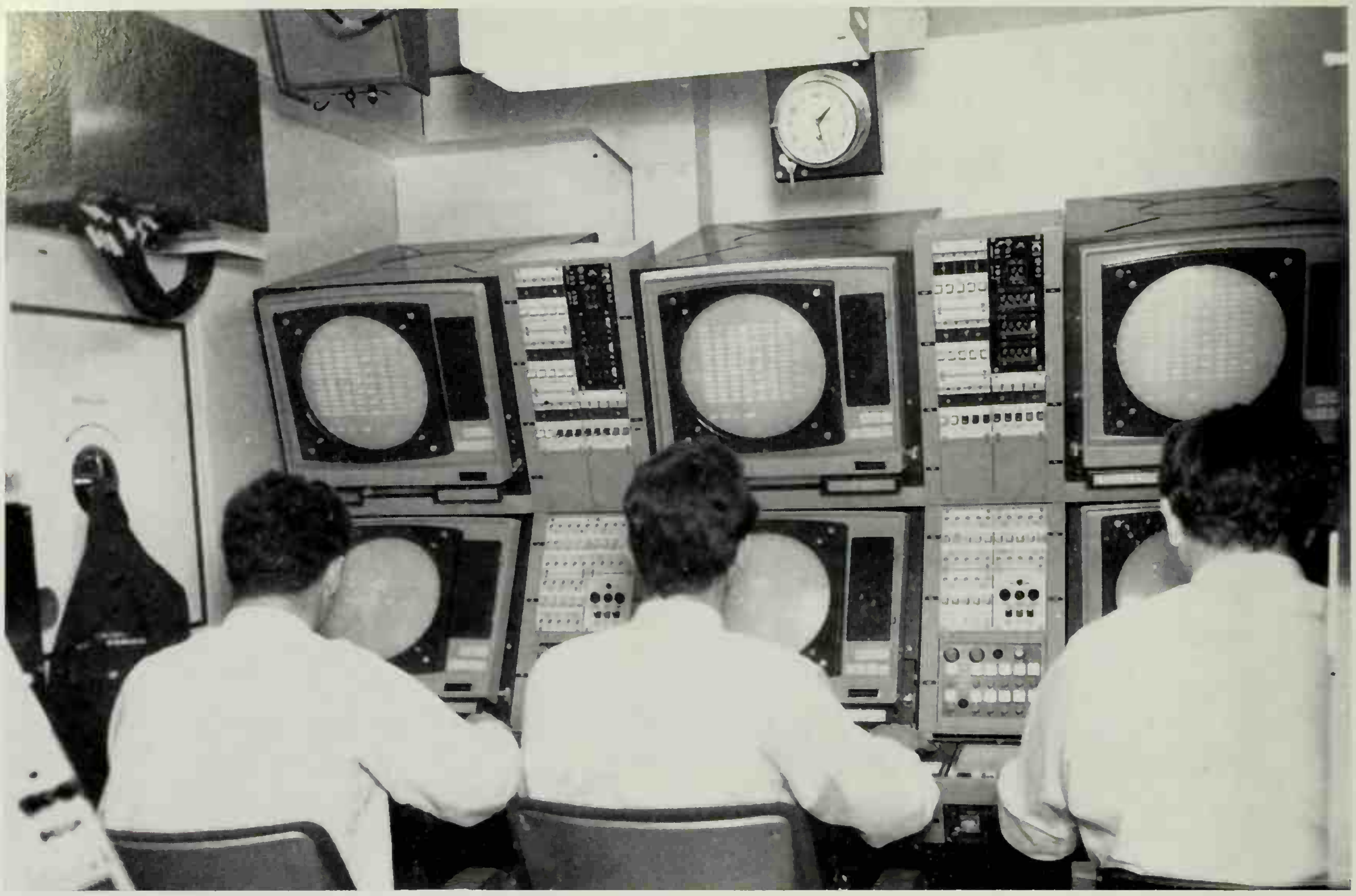

Above: Plessey air-portable control and reporting unit comprising radar, communications, display and data-handling facilities. It provides surveillance of air space, computer-controlled fighter and surface-to-air missile interception

Below: An air-portable tactical air control display and data-handling sub-system. Operating with a variety of radar sensors, it provides simultaneous fighter and surface-to-air missile interception facilities

Air defence systems

Radar display and data handling

Plessey Radar Limited has nearly 20 years' experience in the design, manufacture and installation of radar systems, civil and military, from single units to complete tactical and strategic complexes.

The company accepts full responsibility for the production of defence systems from initial feasibility studies to final trials and comprehensive post-design services. Such systems may include primary and secondary radar, displays and computers. Where collaboration is required with suppliers of associated equipment the company undertakes overall system management.

The company employs an engineering team of over 300 people. Their specific expertise in data-handling systems, digital computer hardware and programming techniques, combined with wide experience of operational requirements, has won for Plessey Radar contracts with British and overseas governments for military air defence and air traffic control systems, including the NATO Nadge project and the United Kingdom Linesman system where the company was responsible for design, development and programming of the computer complex. It comprises a number of Plessey XL Series computers, together with a fast central storage equipment, magnetic drum and tape storage, all interconnected by a data highway system. Plessey Radar has also been retained as consultant on air defence problems.

Equipment manufactured by Plessey Radar for military and civil systems includes:

Secondary radar (IFF)

Plessey Radar secondary radar systems consist of a series of modular equipments ranging from antenna to displays which can be installed to meet individual system requirements and offer the choice of manual or automatic decoding.

Primary and secondary radar plot extractors

This equipment has been developed to process all types of primary radar signals, to decode SSR signals automatically and to correlate the two. Primary 'clutter' returns and SSR 'fruit' is rejected before signals are transmitted from the radar head over narrow-band links (telephone cables) to the operations room. Plessey Radar plot extraction systems are compatible with a wide range of surveillance radars.

Plessey Mk 8 40 cm (16-inch) modular radar display unit shown in an autonomous configuration

Mk 8 radar displays

To meet the stringent operational demands of military authorities throughout the world, the Mk 8 autonomous viewing display is available with a 30 cm (12-inch) or 40 cm (16-inch) cathode-ray tube or horizontally mounted 55 cm (22-inch) conference display. They may be used in various roles such as:

Conventional radar display
Bright-viewing display
Labelled radar display
Synthetic radar display
Tabular display

The Mk 8 display is compatible with most radar sensors.

Touchwire displays

Touchwires provide a simple, silent, unambiguous, semi-interactive device for man-computer communications.

A transparent overlay is moulded to fit any CRT display. Metallic touchwires, positioned ergonomically to suit the application of the particular display, are embedded in the overlay. The touchwires are individually labelled on the CRT by the computer and the operator makes his selection by touching the appropriate wire. Touch-sensing elements detect the wire touched and provide a unique binary code to the computer.

Touchwires are in operation with government and air traffic control agencies in the United Kingdom and abroad.

Scan converter systems

Scan conversion enables controllers to view displays under controlled daylight. Radar returns are shown at a high brightness level without normal after-glow fading, essential for the maximum utilisation of secondary radar data. Plessey Mk 8 displays are available as bright-viewing displays.

Minicom

Minicom is a radio and intercom control system which provides a reliable and flexible control system for the complex communication systems required by multiple radar sites and operations rooms. The system is completely self-contained and allows overall control of HF, VHF and UHF radio and landline communication.

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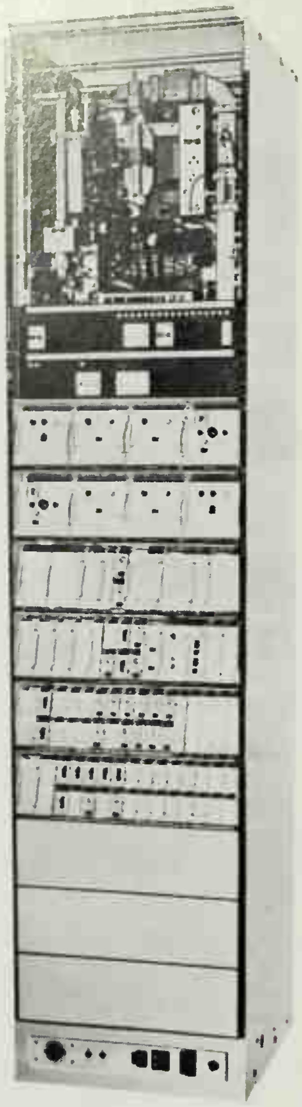
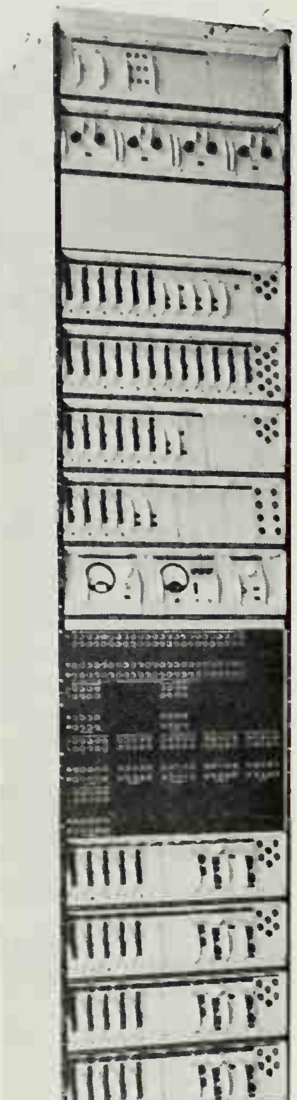
Section 24

Radio transmitters and receivers



7·5 GHz radio-transmission equipment comprising duplicated transmitter/receivers and modulator/demodulators. The rack illustrated also includes a supervisory system to monitor the performance of the complete link

A suite of carrier-multiplex equipment racks



A rack of telegraph equipment. The equipment practice used, designated CASE, allows a wide range of equipment configuration within the one rack. This particular rack includes both 24 VFT and 6 VFT + speech telegraph equipments in addition to a test shelf and a patch panel to permit continuous monitoring of transmission

600/1200 baud data modem

Fixed-link systems

for telephony, telegraphy and video communications

GEC telecommunications systems for the transmission of telephony, telegraphy and video are used by the Ministry of Defence in the UK and by defence organisations in many other countries for fixed communication links. A complete service is available including planning, surveying, installation, and maintenance.

Carrier multiplex equipment

translates up to 2700 individual speech-bandwidth channels into an FDM (frequency-division multiplex) baseband for application to line, cable, or radio bearers. Many alternative operating arrangements are possible: for example, duplicated or non-duplicated carrier- and pilot-generating equipment can be supplied for any of the systems; synchronising, group- and supergroup-reference pilots can be provided; signalling can be inband or outband; power supplies can be ac or dc.

Speech circuit capacity	Suitable bearer	Telephony baseband
5	Radio	300 Hz to 24 kHz
12	Line or radio	6–54 kHz
24	Line or radio	6–54 and 60–108 kHz
60	Radio	12–252 or 60–300 kHz
300	Radio	60–1300 kHz
600	Radio	60–2540 kHz
960	Radio or coax cable	60–4028 or 316–4188 kHz
1800	Radio	312–8204 kHz
2700	Coax cable	312–12 336 kHz

Speech input: –4 dBr nominal, 600 Ω balanced
Speech output: +4 dBr nominal, 600 Ω balanced
Output to bearer (nominal): up to 60 circuits, –35 dBr; up to 960 circuits, –45 dBr; above 960 circuits, –37 dBr (radio) or –45 dBr (coax cable); 75 Ω unbalanced
Input from bearer (nominal): up to 60 circuits, –30 dBr; 300 circuits, –15 dBr; up to 960 circuits, –20 dBr; above 960 circuits, –28 dBr (radio) or –25 dBr (coax cable); 75 Ω unbalanced

7·5 GHz microwave radio transmission system

is ideal for medium-distance trunk routes. Each radio bearer can carry up to 300 speech channels. The system is extremely compact: a single rack contains duplicated transmitter/receivers and modulator/demodulators together with subtrafficband supervisory equipment and the SHF (super-high frequency) waveguide combining equipment. This completely semiconductored equipment, with its inherent reliability, minimum maintenance and low power consumption, is particularly useful where access to remote stations is difficult.

Operating frequencies: 7·425–7·725 GHz
Transmitter output (at rack monitor points): 200 mW nominal
Baseband capacity: up to 300 circuits (300–3400 Hz)
Baseband frequency range: 60–1300 kHz plus 300 Hz to 24 kHz or 54 kHz serviceband
Power supply: 24 V dc, nominal; ac operation can be arranged
Dimensions: height 2286 mm (7 ft 6 in); width 520 mm (20½ in); depth 445 mm (17½ in)

The following table lists the range of microwave radio transmission systems:

Radio bearer frequency range	Telephony channel capacity	Frequency limits of baseband	Pilot frequencies
1·7–1·9 GHz	600*	60–2792 kHz	8·5 MHz
1·9–2·3 GHz	600*	60–2792 kHz	8·5 MHz
3·79–4·2 GHz	1800	300–8248 kHz	9·023 MHz
5·925–6·425 GHz	960	60–4287 kHz	8·5 MHz
6·425–7·110 GHz	960	60–4287 kHz	8·5 MHz
7·425–7·725 GHz	300	60–1300 kHz	4·6 and 4·9 kHz

* Can be extended to 960 circuits for short-haul applications

Telegraph equipment

Up to 24 duplex VFT (voice-frequency telegraph) channels can be provided over a single four-wire 300 – 3400 Hz speech channel and the composite signal is suitable for transmission over physical circuits, carrier systems or radio links. Transmission speed is 50 baud and the equipment is arranged for double-current working. The 24 VFT channels are spaced at 120 Hz intervals in the speech band. The frequency shift is ±30 Hz per channel.

An alternative arrangement provides up to six duplex 50 baud VFT channels, plus a restricted-bandwidth speech circuit, over a single four-wire 300 to 3400 Hz speech channel; the equipment can be arranged for either double- or single-current working. The six VFT channels are spaced at 120 Hz intervals at the high-frequency end of the speech band; the upper limit of the speech circuit is restricted to 2300 Hz.

600/1200 baud data modem equipment

converts data-pulse information into voice-frequency signals for transmission over a two-wire telephone connexion. Received signals are re-converted into data format. Two switch-selected speeds of operation are provided: up to 600 bauds and up to 1200 bauds.

Each modem is equipped with one modulator and one demodulator; either or both may be for 600/1200 baud operation. 75 baud operation is used for return supervisory and control data. A pair of modems can operate over switched networks or leased connexions.

Junction-radio systems

operate in the UHF band and can provide five or twelve telephone circuits over routes where it is not economic to provide landlines or high-capacity microwave systems. The separation between stations may be up to 65 km (40 miles). Several radio hops may be used in tandem, the limit being imposed by the maximum acceptable noise.

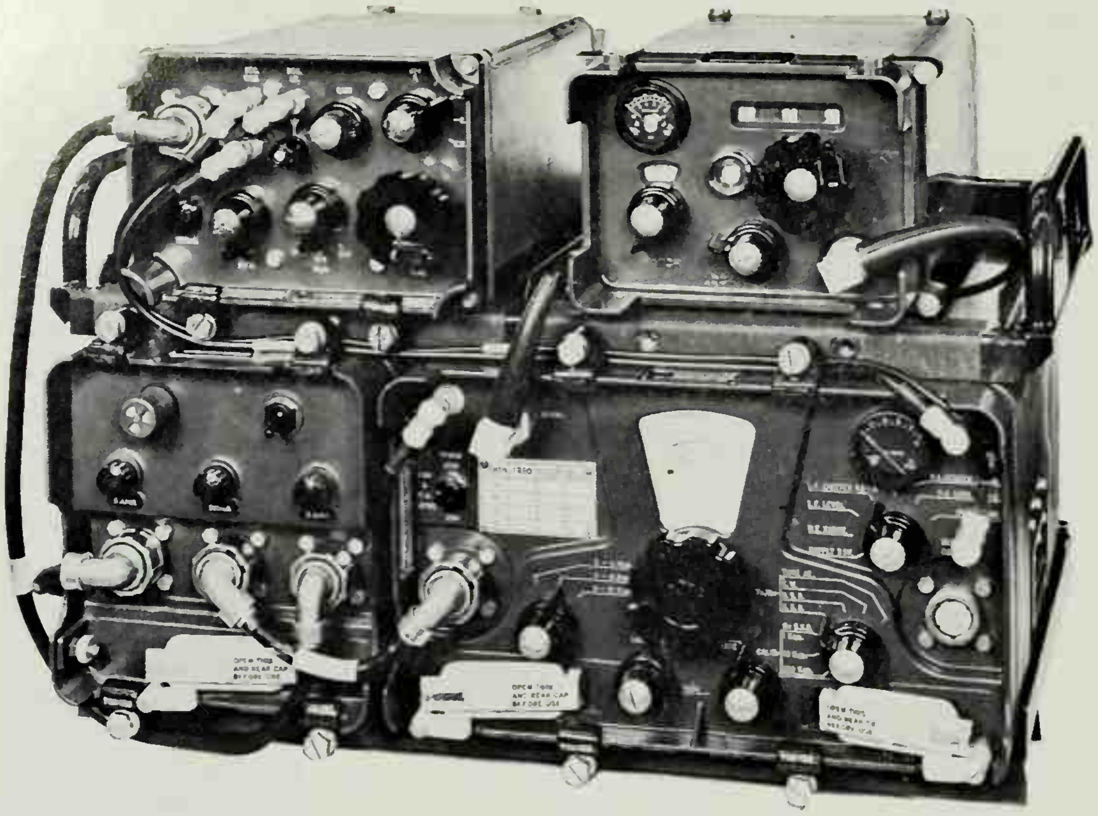
Operating frequencies: 445–500 MHz
Minimum RF channel spacing: 5-circuit, 200 kHz; 12-circuit, 500 kHz
Transmitter output power: 10 W nominal
Receiver noise factor: 4–7 dB
Power supply: normally 24 V dc; ac or 50 V dc operation can be arranged
Dimensions: height 915 mm (36 in); width 520 mm (20½ in); depth 445 mm (17½ in)

Lincompex

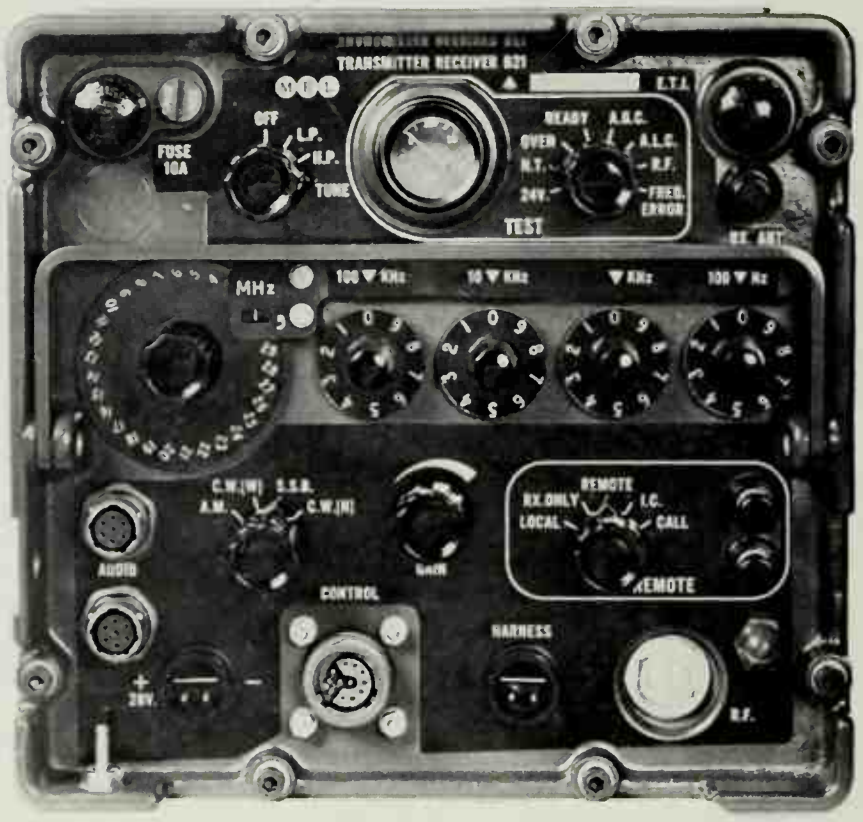
brings the quality of HF radio-telephone circuits up to line-transmission standards. It reduces even syllabic variations in speech level to give an output of sensibly constant amplitude for transmission over the link. Speech amplitude information is contained in a separate frequency-modulated tone transmitted with the compressed speech over a 3·1 kHz channel.

A Management Company of The General Electric Co Ltd of England
GEC-AEI TELECOMMUNICATIONS LIMITED
Transmission Division
PO Box 53, Coventry, CV3 1HJ, England
Telephone: Coventry 52152 Cables: Springjack Coventry Telex: 31361

G.E.C.



The MEL C11(SSB) station radio is the current HF equipment of the British Army for use in all types of vehicle


TRANSMITTER RECEIVER 321
FUSE 10A
OFF
L.P.
H.P.
TUNE
READY
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OVER
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A.L.C.
R.F.
FREQ. ERROR
TEST
RX. ANT
MHz
100 ▼ KHz
10 ▼ KHz
▼ KHz
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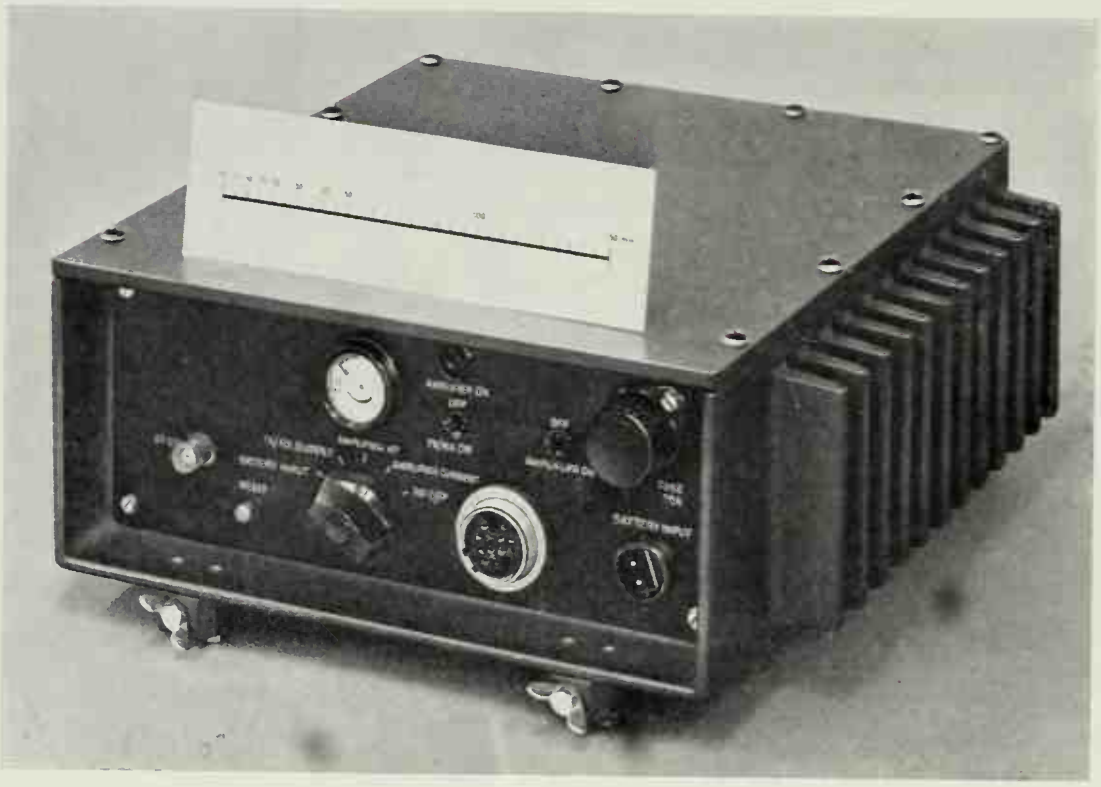
C.W.(W)
S.S.B.
A.M.
C.W.(N)
GAIN
REMOTE
RX.ONLY
I.C.
LOCAL
CALL
REMOTE
AUDIO
CONTROL
HARNESS
+ 28V.
R.F.

The UKVRC 321 HF receiver/transmitter. The new HF vehicle set for the British Army



The 100 W linear amplifier Type BA 1013 for use with HF packsets in vehicle roles

Mobile HF radio equipment

for vehicles and portable use

C11 (SSB) station radio

Produced to the exacting requirements of the British Army, the C11 (SSB) is one of their current HF equipments.

Military role

This transitorised radio system is designed specifically for a mobile military role for use at division, brigade and battalion levels. The equipment may also be used as a fixed station system. The complete equipment which comprises transmitter, receiver, aerial tuning unit and ac or dc supply unit, is small enough to facilitate installation into a variety of military type vehicles. The performance of the equipment will ensure satisfactory voice, morse or teleprinter (with adaptor) communication up to distances of at least 1000 km.

Operation

The C11 (SSB) system covers an HF frequency range of 2–16 MHz, provides for the selection of any one of 14 000 different frequency channels, and has a power output of 120 W peak envelope power. The equipment may be operated from a 20–32 V dc supply, or from 100–125, 200–250 V ac, 45–65 Hz via the ac power supply unit. The C11 (SSB) is of compact and rugged design with easy access for maintenance provided by the extensive use of plug-in sub-assemblies.

UKVRC 321 HF combat radio

The UKVRC 321 receiver/transmitter is the new British Army 'Clansman' HF vehicle set. It provides communication facilities over long and short links for infantry, armoured or soft-skin vehicles, gun and missile batteries, beach landing and parachute units and ground-to-air links.

The UKVRC 321 consists of a RT 321 receiver/transmitter and a manual or remotely operated antenna tuning unit. It is simpler to operate, more reliable, more efficient, smaller and lighter than the sets which it replaces, in addition to providing increased protection against mutual and hostile interference.

Features

Digital frequency selection in 100 Hz steps over the band 1·5 to 29·9999 MHz; built-in narrow telegraph band facility; all frequencies synthesised from one reference oscillator, with a warm-up time of less than 90 sec; wide use of micro-miniaturisation and integrated circuits to reduce size, weight and power consumption, and to ensure high reliability; operation from any battery at 20–32 V, with up to 7 V peak-to-peak ripple, up to ± 600 V transients, and surges up to + 100 V; power consumption of only 25 W on receive, and 120 W on transmit to provide 40 W peak envelope power output; sub-unit construction with in-built test facilities for rapid maintenance; provision of direct connection for audio gear and compatibility with 'B'-type harness.

Military roles

Vehicular battalion—company. Vehicular division and brigade SSB command set. Vehicular HF SSB receiver/transmitter for regimental roles, particularly armoured cars/tanks, etc. Lightweight SSB receiver/transmitter for formation and rear link use in early stages of air-transported operations.

100 W linear amplifier Type BA 1013

This wideband untuned solid-state amplifier is intended as an add-on unit to a low-power transmitter/receiver, for example a packset, whose transmitter output power is not less than 5 W peak envelope power.

Operation

The amplifier may be operated from any 20–32 V dc supply without any change of tap settings or other adjustments. The power supply is self-contained and provides a supplementary output of 20 W at 24 V dc for the operation of an associated packset. Operation at specified duty cycles is continuous in ambient temperatures between −20°C and +55°C.

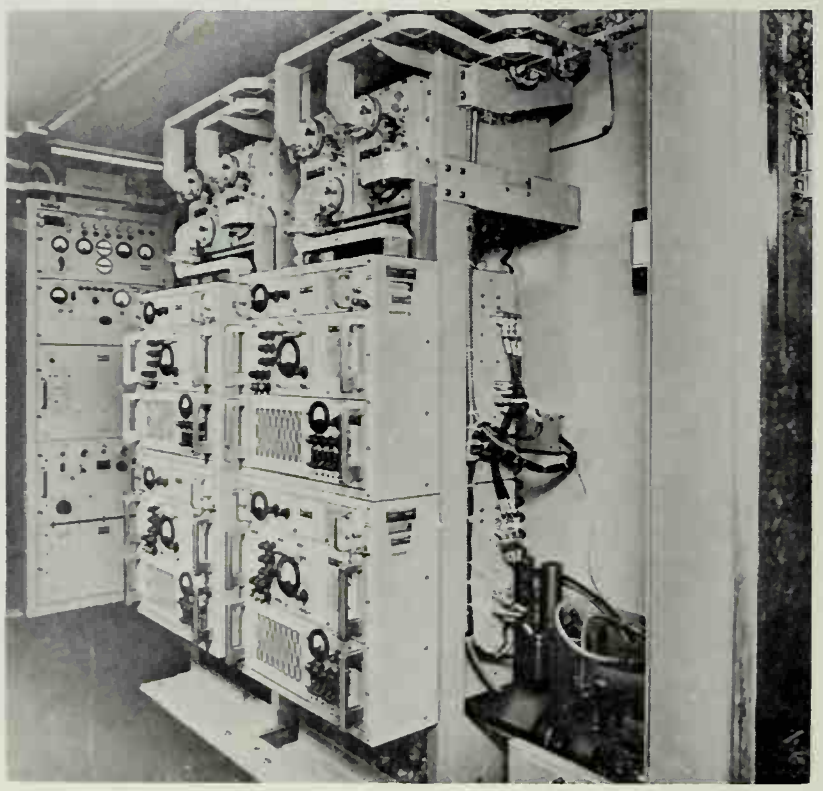
THE MEL EQUIPMENT COMPANY LIMITED
Defence Systems Division
Manor Royal, Crawley, Sussex, England
Telephone: Crawley 28787 Telex: 87267

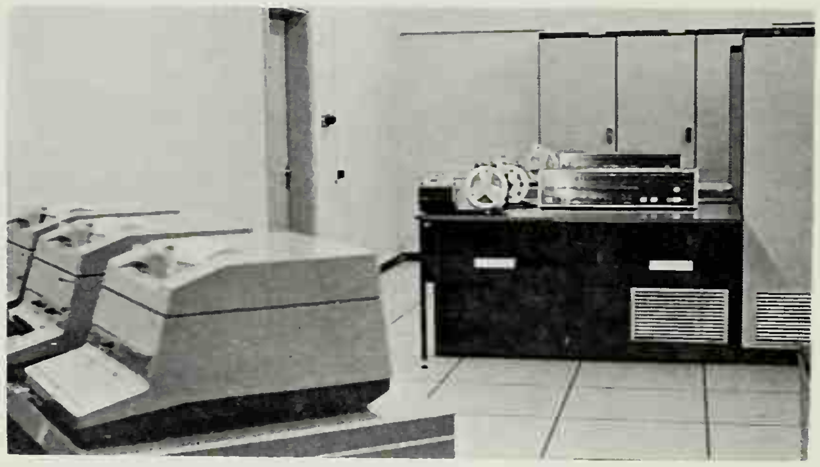
MEL

Above left: 7½ kW MST transmitter and drives, installed in a transportable container

Above right: A self-contained wireless station installed on a 1-ton truck

Right: Tropospheric scatter exciter equipment in a transportable shelter





Above: Mobile military stations awaiting delivery

Below: MARS message switching installation

Right: 12·8 m (42 ft) diameter space communications antenna

Military radio systems

Complete range for communications networks

Marconi's long and wide experience in the provision of military communications systems has led to the development of large-scale transportable HF systems employing the well-known Marconi self-tuning (MST) system, such as that supplied to SHAPE, and compact self-contained transportable HF wireless stations, which have been sold in large numbers to British and overseas armed forces.

Marconi transportable MST systems

Marconi transportable MST systems comprise the following equipment:

- Complete MST transmitting, receiving and systems control containers
- Air-conditioned, robust containers suitable for loading on vehicles, ships, etc, requiring the minimum of site preparation
- Containers for 7½ kW or 1 kW transmitter with comprehensive synthesiser drive assemblies
- Transmitter site control containers with line patching and monitoring equipment suitable for controlling a complete site of ten or more transmitters
- Receiver containers and receiver site control containers for four or more dual diversity isb receivers with line-patching and monitoring equipment incorporating fsk adapters
- A range of transportable short or long-range log-periodic aerials; monopoles and dipoles can be provided as necessary.

Transportable HF wireless stations

These are entirely self-contained mobile communications station for isb, ssb, fsk with full operational facilities. The equipment is installed in a transportable shelter and can be mounted on a 1-ton truck. It provides reliable communications by ground-wave up to 112 km (70 miles) over average rolling countryside with a choice of four or six operational spot frequencies or with a synthesised drive. Operation is rapid and simple. Remote control of the equipment in all services can be provided.

Transportable tropospheric scatter communications systems

Transportable tropospheric scatter systems for operation over distances up to 480 km (300 miles) in rugged air-conditioned shelters can be engineered to meet specific requirements.

They are available for 1 GHz, 2 GHz and 5 GHz operation. Because they are easily transportable their redeployment presents no problems. The circuitry is solid-state throughout and power outputs of 100 W, 1 kW or 10 kW are available, with 3 m, 4·5 m or 9 m (10 ft, 15 ft or 30 ft) aerials.

Operation can be in quadruple or dual diversity mode.

Military automatic message switching systems

The Marconi Automatic Relay System (MARS) has been designed using the very latest techniques in digital communication to provide automatic relay of messages in a telecommunications network, according to any prescribed procedure and formats. MARS systems have been ordered for the British Ministry of Defence (Army) and for NATO.

The outstanding features of the equipment are:

- Fully automatic operation—manual intervention or papertape is unnecessary for normal message flow
- High reliability, attained by advanced design concepts through the use of micro-electronics and high-quality components
- Continuous operation—uninterrupted operation is guaranteed by parallel operation
- Flexibility—programmed computers ensure complete flexibility of message-handling techniques
- Adaptability—MARS deals with mixed traffic speeds, precedence levels and formats
- High speed—the equipment is capable of handling messages at the rate of at least 5 per second
- Simplicity of control, MARS being specifically designed to require no special operating skills.

Military space communications earth station

Marconi has been involved in space communication for many years and in 1965 was awarded a major contract by the Ministry of Defence to design and manufacture three air-transportable military earth stations for use in a joint Anglo-American project. Three years later, one of the most valuable space terminal contracts ever placed outside the USA was awarded to Marconi by the British Ministry of Technology. It covered the modification of two of the original stations which were operating overseas, and the supply of a complete 12·8 m (42 ft) diameter fixed station of a new Marconi design.

This fully steerable aerial has a quasi-parabolic reflector of high profile accuracy with a Cassegrain sub-reflector and a four-horn feed system. The station employs duplicated uncooled parametric amplifiers, duplicate 20 kW 8 GHz transmitters and provides a dual path transmission for digital and FM signals. The 'alt-az' mount is suitable for tracking both synchronous and medium-altitude satellites.

A GEC-Marconi Electronics Company
MARCONI COMMUNICATION SYSTEMS LIMITED
Radio Communications Division
Marconi House, Chelmsford, Essex, England
Telephone: Chelmsford 53221 Cables: Expanse Chelmsford Telex Telex: 99201

Marconi

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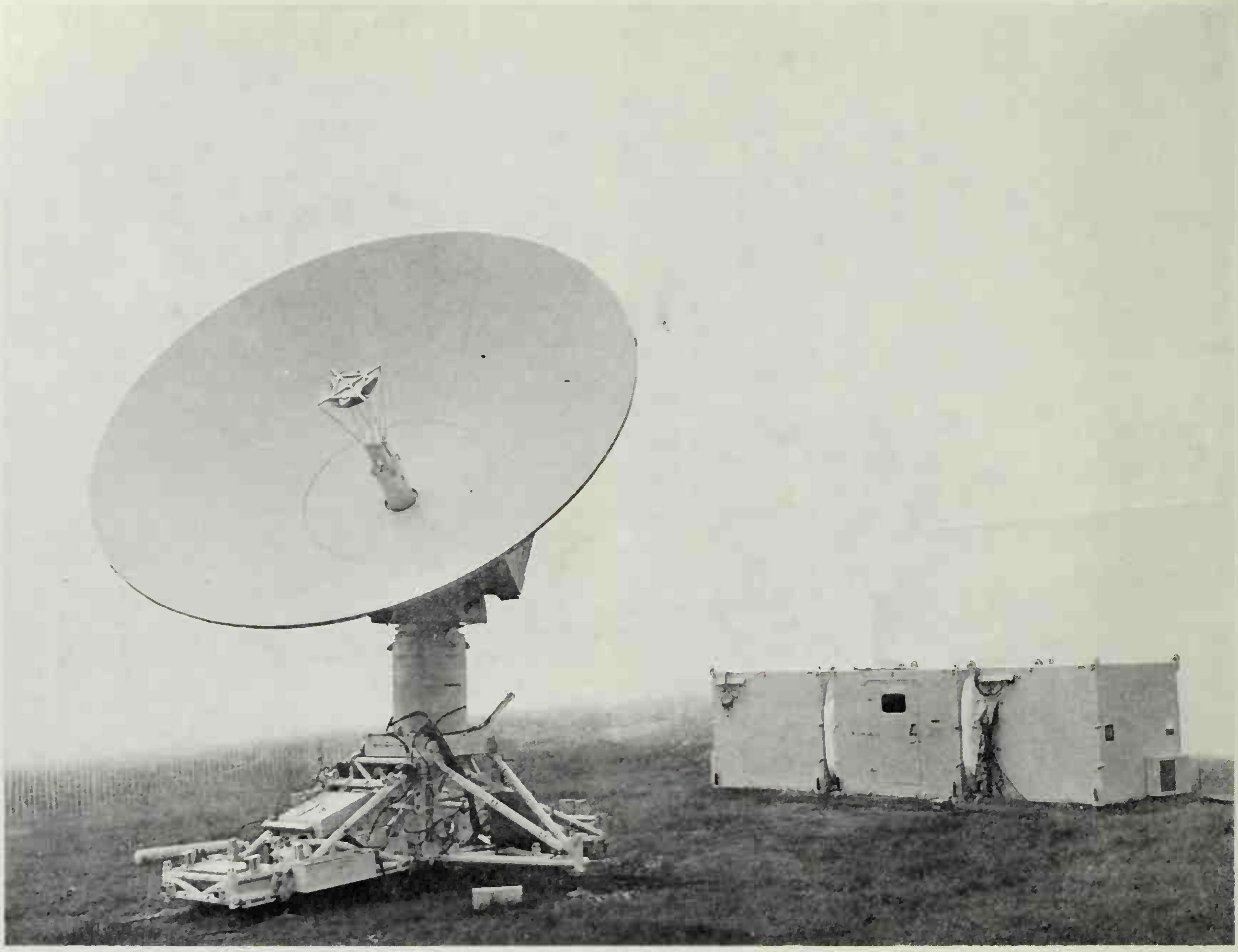
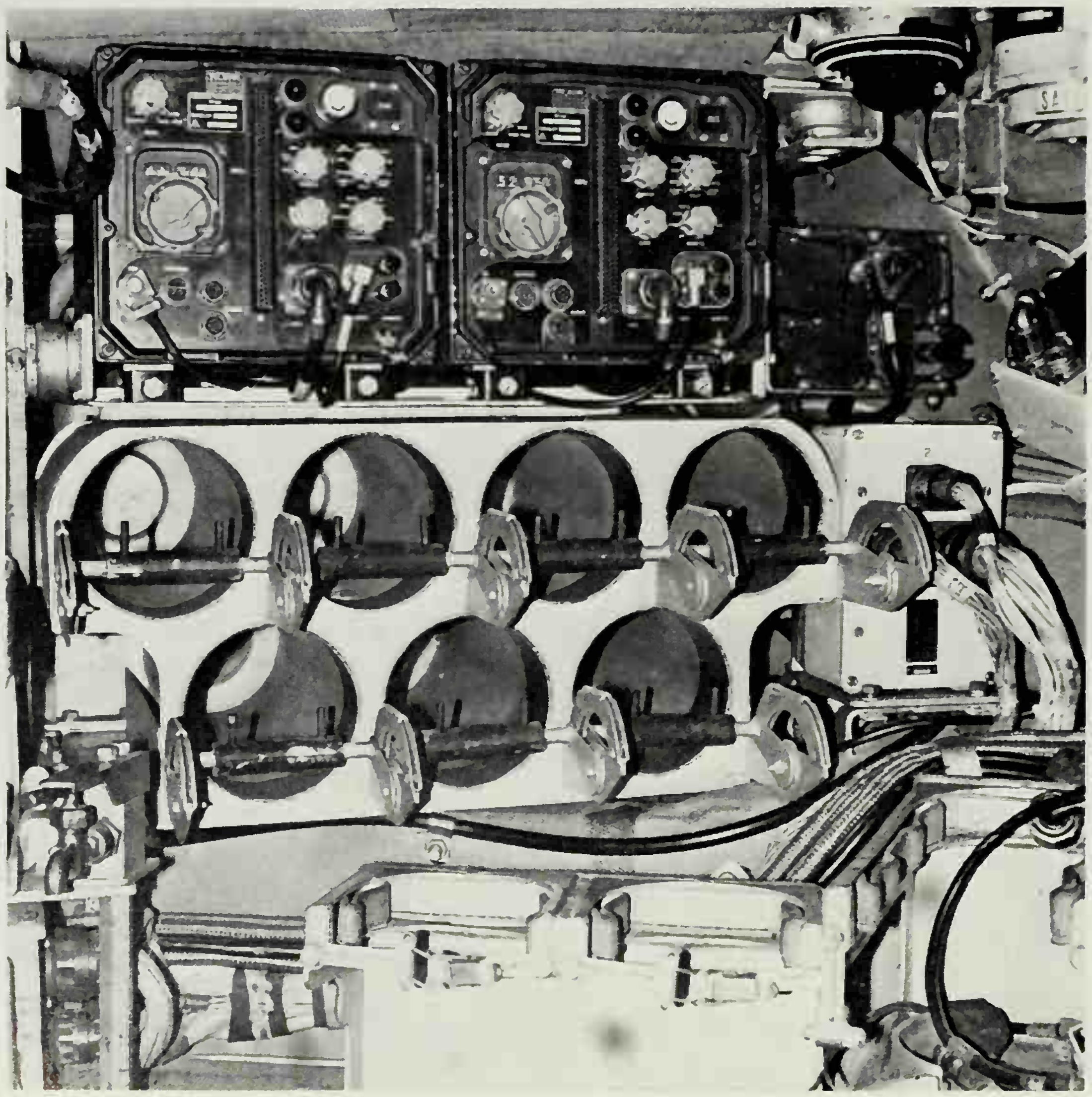


A complete ATES (air-transportable earth station) with 6·4 m (21 ft) diameter dish antenna and three control cabins



Dual VHF Clansman communications system installed in a Chieftain tank

Communications systems

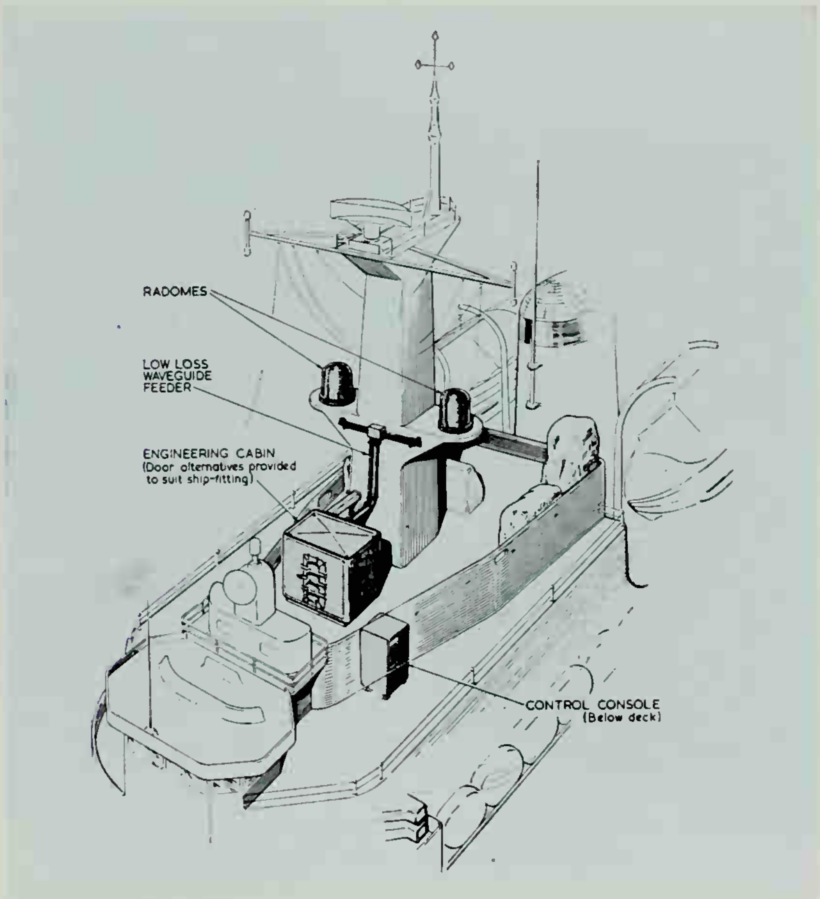
for all armed services

Air-transportable earth station (ATES)

This consists of a 6·4 m (21 ft) diameter dish antenna with transmitter and receiver units mounted immediately below it on the same pedestal. The antenna is of cassegrain design incorporating high-efficiency main and sub-reflector profiles and a five-horn monopulse feed. The water-glycol-cooled transmitter employs a klystron power amplifier and has an output of 5 kW. The parametric receiver amplifier is cooled by liquid nitrogen. Three air-conditioned cabins are provided; for operational purposes they are mounted in line, the centre cabin affording an entrance porch, the other two cabins housing the radio equipment and the modem and channelling equipment respectively. The whole station can be broken down into packages of 1800 kg (4000 lb) each or less and can be air-transported by two Hercules aircraft. If desired each station package can form a helicopter lift. Provided with the station are standard four-wheeled mobilisers on which the station packages can be mounted for towed transport over land. Each mobiliser is equipped with brakes and lights and with a hydraulic jack for mounting and demounting the packages, which can be achieved by two men. The station can be erected in four hours by six men and, when operating, a watch crew of only two men is required. The station is designed to provide secure communications facilities for the Skynet system in a fixed role at Bahrain, at Gan and in the UK. It can also be deployed to meet emergency requirements.

Shipborne communications terminal (SCOT)

This consists of an antenna system in which a 1·07 m (3½ ft) diameter dish antenna is mounted on each side of the ship's mast. The antennae are each housed in a double-skinned radome and are made independent of ship motion by a rate gyro stabilisation unit. All active communications equipment is housed in a prefabricated and unmanned engineering cabin at upper deck level and connected to the antennae by a low-loss waveguide run. This arrangement affords high reliability and renders all elements of the system readily accessible for maintenance purposes. All essential operational controls are located at a control console in the ship's main communications office. From this position an operator is able to switch on the transmitter, to acquire the satellite, to select the appropriate receive frequency and to monitor equipment operation. The station is designed for installation in warships down to and including the frigate classes and its function is to provide secure communication between ships at sea and certain selected shore terminals in the Skynet system.


RADOMES
LOW LOSS WAVEGUIDE FEEDER
ENGINEERING CABIN (Door alternatives provided to suit ship-fitting)
CONTROL CONSOLE (Below deck)

Military communications

Early work on digital speech systems has been so successful that the company has supplied practically every piece of equipment of this type in use by the British armed forces, and new developments represent an important part of its activities.

It has participated in the system studies for the Hobart and Mallard comprehensive military tactical communication systems, and is currently taking part in the phase 2 work for Mallard.

It has been responsible for the development of the VHF/FM radio-telephone set for Clansman, the most technologically advanced range of HF and VHF net radios in the world. The VHF/FM set is numerically the largest single item in the range and is for use as a single or multi-set installation in armoured and soft-skin vehicles.

Important work has been done on experimental pseudo-noise, spread-spectrum and range-measuring equipments for the Skynet military satellite communication system. Other current projects cover a very wide range of advanced techniques, including those for voice-compression, digital speech and its modulation, detection and reconstitution, analogue/digital and digital/analogue conversion, and the multiplexing of speech and data.

In all this work, the widest possible use is being made of the most modern techniques of microminiaturisation in the interests of reliability and equipment packaging.

A GEC-Marconi Electronics Company

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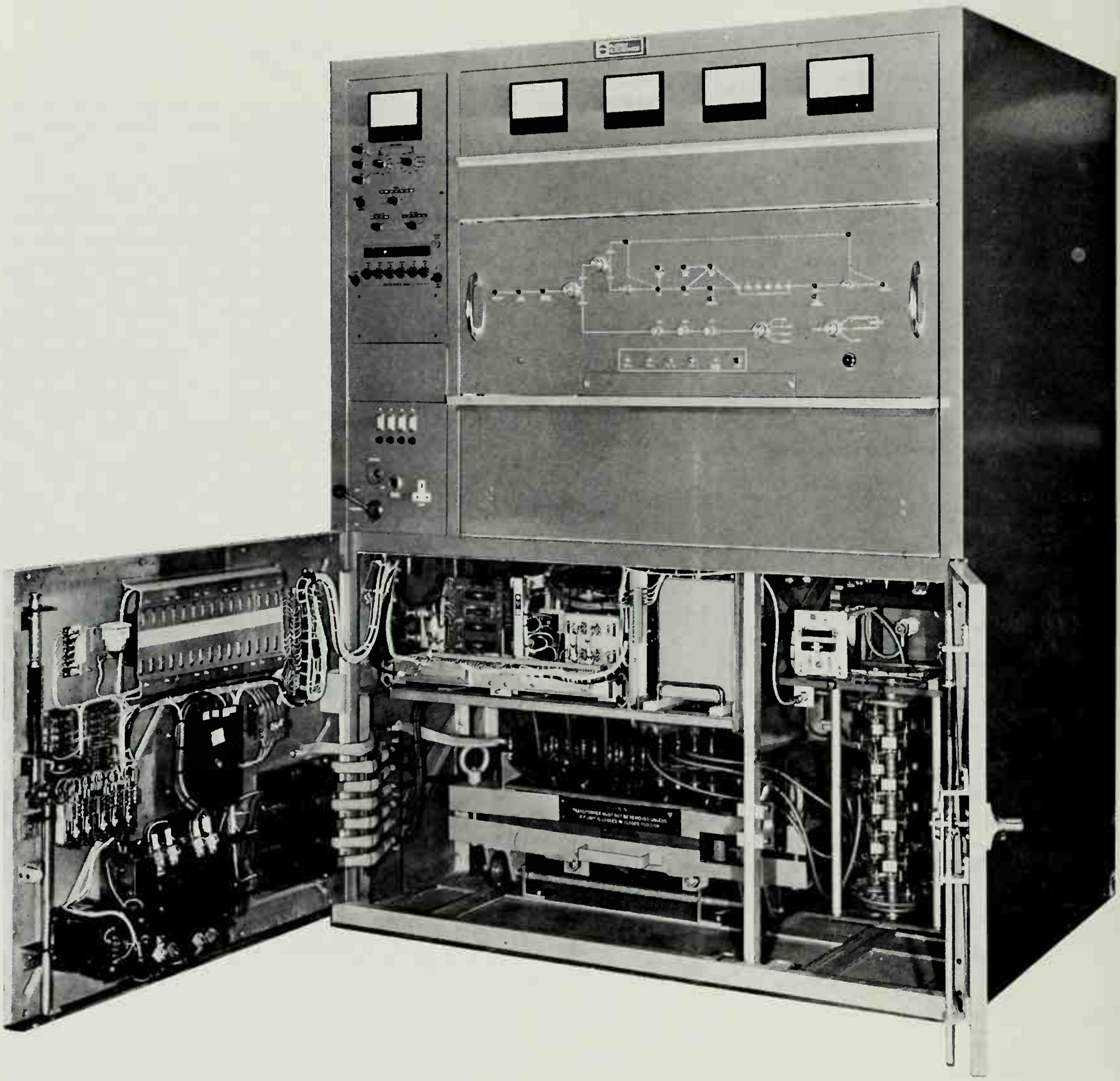

The Plessey PVT 350 10 kW HF transmitter is a simple and robust yet versatile station

Containerised systems

With the ever-increasing requirement for highly mobile stations of from 1 to 10 kW rating, Plessey has designed containerised stations that are readily transportable by land, sea or air.

The ability to provide this facility is enhanced by the design of the transmitters and their ancillary equipment. These equipments utilise solid-state techniques, completely automatic tuning and can be maintained by unskilled personnel. Frequency ranges are from 2 MHz to 30 MHz and up to 280 000 channels are available at 100 Hz spacing. The modulation flexibility of these equipments is such that all modes in general use can be readily accommodated. Full remote control facilities, together with receiving equipment and a wide range of antennae are available.

HF radio transmitter

Point-to-point/ground-to-air station

PVT 350 10 kW HF transmitter

Main characteristics

The PVT 350 is a 10 kW self-tuned transmitter which covers the band from 2 MHz to 30 MHz and is intended for point-to-point and ground-to-air operation in fixed station service or in an air-transportable role. The transmitter has been designed for low operational cost, high reliability and flexibility for system planning. It is suitable for operation in A1, A2, A3A, A3B, A3H, A3J, A7A, A7J, A9B, F1, F4 and F6 modes and the overall bandwidth of 6 kHz permits multi-channel speech and telegraph transmissions. Frequency changes are accomplished in less than 30 seconds. Completely automatic tuning facilities, coupled with a high degree of reliability, render the equipment eminently suitable for operation by unskilled personnel, and provision is made within the transmitter for the inclusion of full remote control. With the exception of the final two stages, solid-state techniques are used throughout. The PVT 360 transmitter comprises a PV 652A drive unit, a PV 340 linear amplifier and an optional PV 650 remote-control system. The transmitter can be operated either locally, with extended control up to 200 metres (630 ft), or remotely, using a single telephone channel transmitted over a cable or radio link.

Systems compatibility

Linear amplification is used, allowing a wide choice of modulation. A synthesiser provides free choice of operating frequency in 100 Hz steps with finger-tip control.

Two spare outlets at 100 kHz, derived from the master oscillator, are provided for use with ancillary equipment to allow the same high standard of frequency stability to be maintained throughout the system.

Remote control of all functions, including frequency selection, is available as an optional feature. The remote control encoder is situated at the control centre and duplicates the set of transmitter drive unit controls. Spare capacity is provided for the control of ancillary equipment.

The modulation flexibility of the transmitter coupled with the ability to select frequencies rapidly equip it admirably for a standby role with minimum redundancy.

Reduced system cost

Many built-in system facilities are included in the basic equipment. These include 100 kHz outlets, spare remote control functions and supply voltage stabilisation which lead to a significant reduction of system costs.

Reliability

With the exception of the final two power amplifier stages, semiconductors are used throughout the equipment.

In addition to discrete transistors, extensive use has been made of digital and linear silicon integrated circuits in all parts of the equipment.

Wideband techniques are used wherever possible to avoid the use of moving parts normally associated with tuning; only the grid and anode of the final power stage are tuned.

Automatic operation eliminates the human element from routine changes of transmitter frequency or mode.

Specification

Audio input

Frequency band: 200 Hz to 6000 Hz or 200 Hz to 3200 Hz

Modulated input

Frequency: 100 kHz

Output

Power output: 10 kW peak envelope power or average

Frequency range: 2 MHz to 29·999 MHz in 100 Hz increments (280 000 channels)

Channel spacing

100 Hz

Modulation

A1, A2, A3A, A3B, A3H, A3J, A7A, A7B, A7J, A9B, F1, F4 and F6 can be transmitted when a modulated tone is available

Frequency stability

Warm-up from 0°C: 1×10^{-6} per hour after 15 min. Short-term variation due to permitted temperature and power supply changes: 1×10^{-8} after 24 hours operation. Long-term ageing: better than 1×10^{-8} per 24 hours within 30 days, continuous operation.

Environment

Temperature 0°C to +55°C at sea level. Relative humidity: up to 95% at 40°C. Altitude: up to 2480 m (8000 ft)

Cooling

Forced air

Power supply

380 V to 440 V ±10%, 50 or 60 Hz ± 5%, 3-phase ac

Power consumption

With 10 kW peak envelope power output single tone: 27·5 kVA, 0·86 power factor. Two-tone 21·6 kVA, 0·86 power factor

Dimensions

Height: 1766 mm (5 ft 6 in) excluding cooling fan and ducting
Width: 1295 mm (4 ft 3 in)
Depth: 991 mm (3 ft 3 in)
Weight: 1000 kg (2200 lb)

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Electronics Group
Vicarage Lane, Ilford, Essex, England
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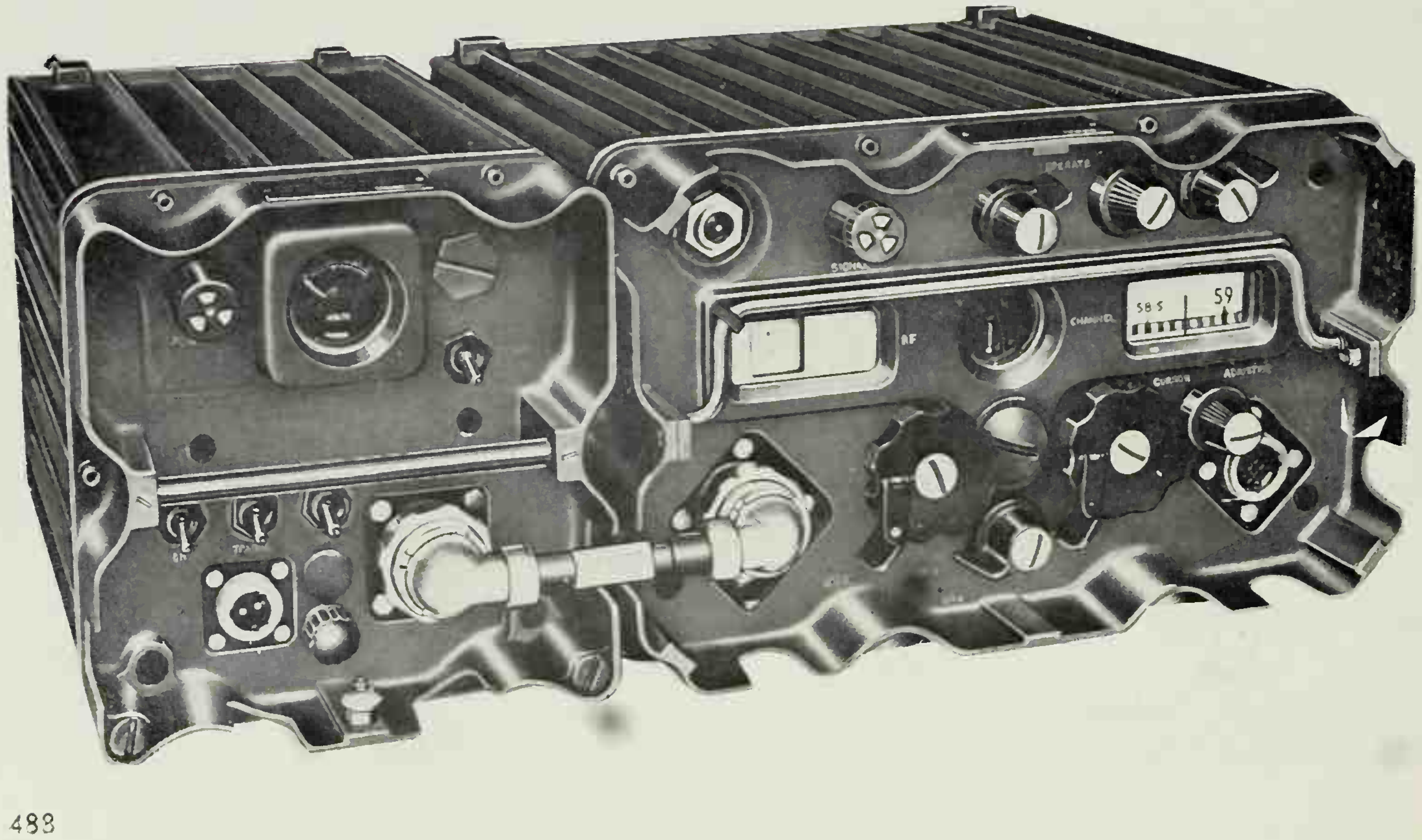
1969

The Electronics Group of The Plessey Company has established a world-wide reputation for research, design, development and manufacture of military UHF, VHF and UHF/VHF equipment. Many thousands of equipments have been produced to meet the demands of the armed forces of more than 20 countries. The Group has the unique distinction of being the largest producer of military equipment in Europe and the prime source of UHF, VHF and UHF/VHF transmitter/receivers for the British armed services.

Above: The Plessey PTR 171A naval transmitter/receiver has a frequency range from 225 to 400 MHz. Output is 16 W

CHANNEL ADJ.
CURS. ADJ.
NOISE ON HP
H.P.
NOISE OFF
L.P.
OPERATE
OFF
POWER ON
SQUELCH

Right: The Plessey B.47 VHF transmitter/receiver, designed mainly for use in fighting vehicles


OPERATE
SIGNAL
RF
CHANNEL
58.5
59

Below: The Plessey C.42 VHF transmitter/receiver for military vehicles, with integral crew intercom facility

UHF and VHF radio systems

for all services and purposes

PTR 171A transmitter/receiver

The PTR 171A is an extremely compact 1750 channel transmitter/receiver covering the frequency band from 225 to 399·9 MHz. The equipment, which is of modular construction, is operated from a control unit which can be situated up to 90 m (300 ft) away from the transmitter/receiver.

The power supply unit (PSU), which is mounted directly beneath the transmitter/receiver, serves as a junction box for all interconnections between units. Cooling of the equipment is by a blower situated in the PSU, which circulates air via a filter through the double-walled heat exchanger case of the sealed transmitter/receiver unit.

Any frequency in the range from 225 to 399·9 MHz is available within six seconds from the megahertz-calibrated control unit, which can be preset or manually selected. A special test set is available which enables the complete installation to be checked by semi-skilled personnel.

Specification

RF power output: 16 W nominal

Transmitter input impedance: 82 ohms

Transmitter sidetone: With the receiver set to 500 mW audio output a signal-to-noise ratio of at least 8 dB is obtained with an open-circuit RF input voltage of 5 µV modulated at 30% by 1000 Hz

Receiver output impedance: Loudspeaker 600 ohms, telemicrophone 300 ohms

Audio output: Greater than 2 W plus 2 outputs of 3 mW into 300 ohms each

Auxiliary output impedance: 20 000 ohms resistive

Receiver selectivity: 6 dB down not less than 90 kHz total, 60 dB down not more than 200 kHz total

Power supplies: Single-phase ac 50–60 Hz 105/120 V, 210/240 V

Power consumption: Receive: 350 VA
Transmit: 500 VA
Channel change: 500 VA

B.47 VHF transmitter/receiver

The B.47 is a short-range frequency-modulated VHF transmitter/receiver designed for operation in armoured and other military vehicles. It provides simplex RT operation on any one of 181 available channels which are spaced at 100 kHz intervals throughout the frequency band from 38 to 56 MHz. A crystal calibrator is incorporated to facilitate accurate tuning.

The transmitter output power is 0·5 W minimum and provides an operational range of approximately 8 km (5 miles) using a standard 2·44 m (8 ft) rod aerial.

The B.47 consists of a combined transmitter-receiver and power supply unit with a separate aerial tuning unit. Tuning of the transmitter/receiver is very simple as the RF oscillator stages of the transmitter-receiver are ganged and may be set up by adjustment of a single knob on the front panel.

The receiver is a single superheterodyne unit providing an audio output preset to 150 mW. This enables up to three sets of 150-ohm headphones to be used.

The transmitter is extremely stable and contains automatic modulation control circuits, which limit the carrier deviation to ±15 kHz for microphone inputs up to 200 mV from a 300-ohm source.

The B.47 can be supplied for operation from either a 12 V dc or a 24 V dc source, as alternative power supply sub-units are available for each of these voltages. There is provision for automatic and manual re-broadcast, either way, through another B.47 or a C.42 or B.48 using a Type A control harness.

C.42 VHF transmitter/receiver

The C.42 is a frequency-modulated VHF transmitter/receiver designed for operation in armoured and other military vehicles. It provides 481 separate speech channels, spaced 50 kHz apart, in the band from 36 to 60 MHz. An integral amplifier provides intercommunication between members of the vehicle crew. Automatic or manual re-broadcast facilities are also included.

The complete C.42 consists of three main units: the transmitter/receiver, the power supply unit, and the aerial tuning unit, each in a fully sealed light alloy case. Servicing is simplified by modular construction.

There are two RF output levels, low power (0·25 W min.) for short-range working and high power (16 W) which enables a range of 16–24 km (10–15 miles) to be covered when using a 2·44 m (8 ft) whip aerial. Ranges in excess of 32 km (20 miles) can be obtained by mounting this aerial on an 8 m (27 ft) mast.

Built-in crystal calibrators enable any frequency, selected on the filmscale, to be accurately calibrated. Correct tuning to the exact frequency is indicated by the zero position on a centre-zero tuning meter. These features obviate the need for 'netting'.

A fully transistorised power supply unit for operation on 24 V dc is available, reducing weight by 4·5 kg (10 lb).

Specification

Electrical

Frequency stability: (a) 12·3 Hz per MHz per °C
(b) 50 Hz per MHz per ± 10% change in supply voltage

Frequency range: 36–60 MHz continuously tunable

Power output: High > 16 W, Low 0·25–0·75 W

Frequency setting accuracy: 0·005%

Receiver sensitivity: 1·0 µV for 10 dB quieting throughout band

Selectivity: At –3 dB 16·5–19 kHz, at –60 dB 55 kHz max

Second channel rejection: > 70 dB

Intercom. amplifier: Output 250 mW max into 30 ohm load, input 75 mV nominal for 250 mW output

Power supply unit: 12 V dc and 24 V dc vibrator or 24 V dc transistor

Mechanical

Transmitter/receiver: 216 × 355 × 361 mm (8½ × 14 × 14¼ in), weight 20·4 kg (45 lb)

Power supply unit: 216 × 203 × 361 mm (8½ × 8 × 14¼ in), weight 13·6 kg (30 lb)

Finish: Drab olive green, black knobs, white engraving, red dial and indicator lights

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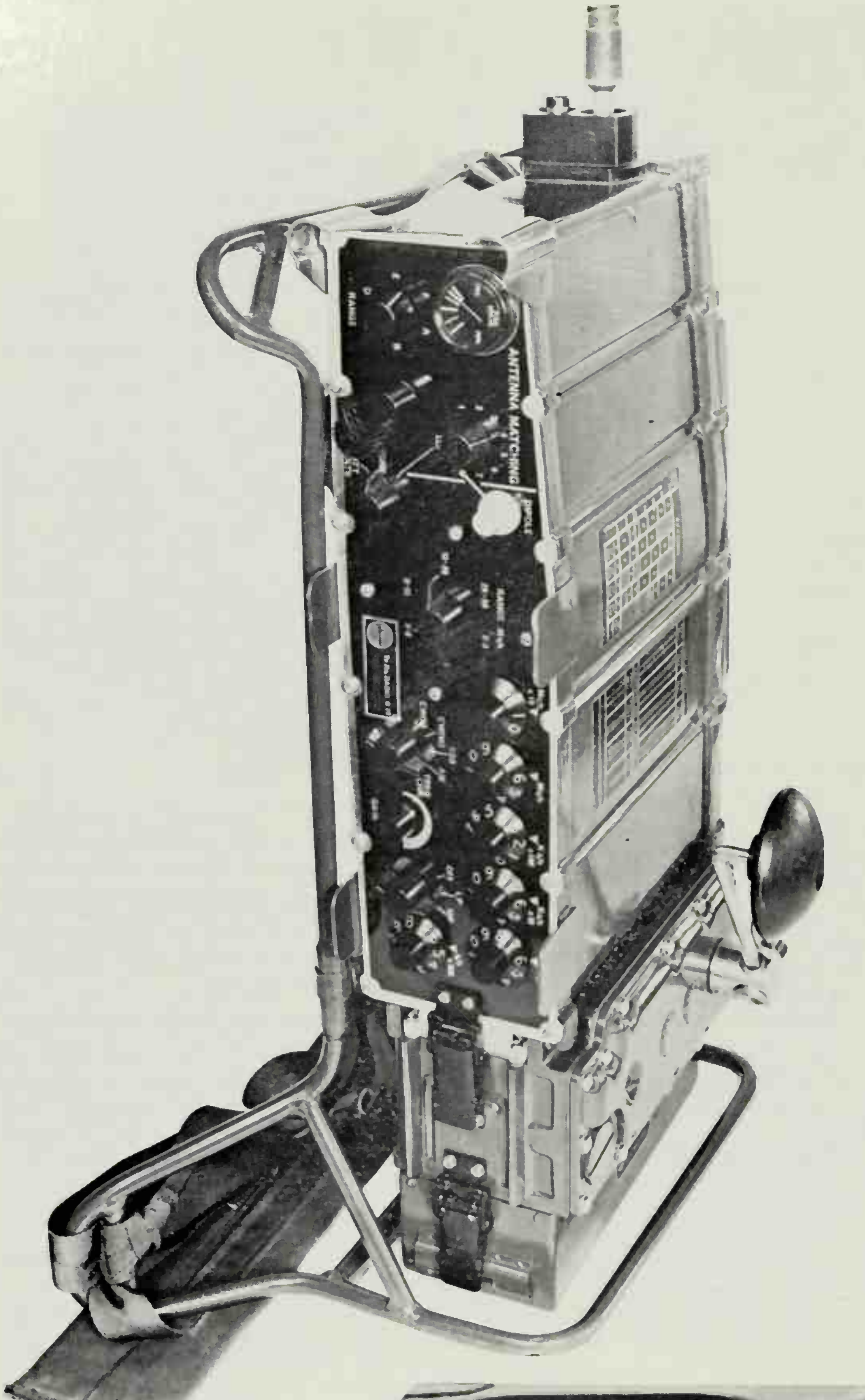
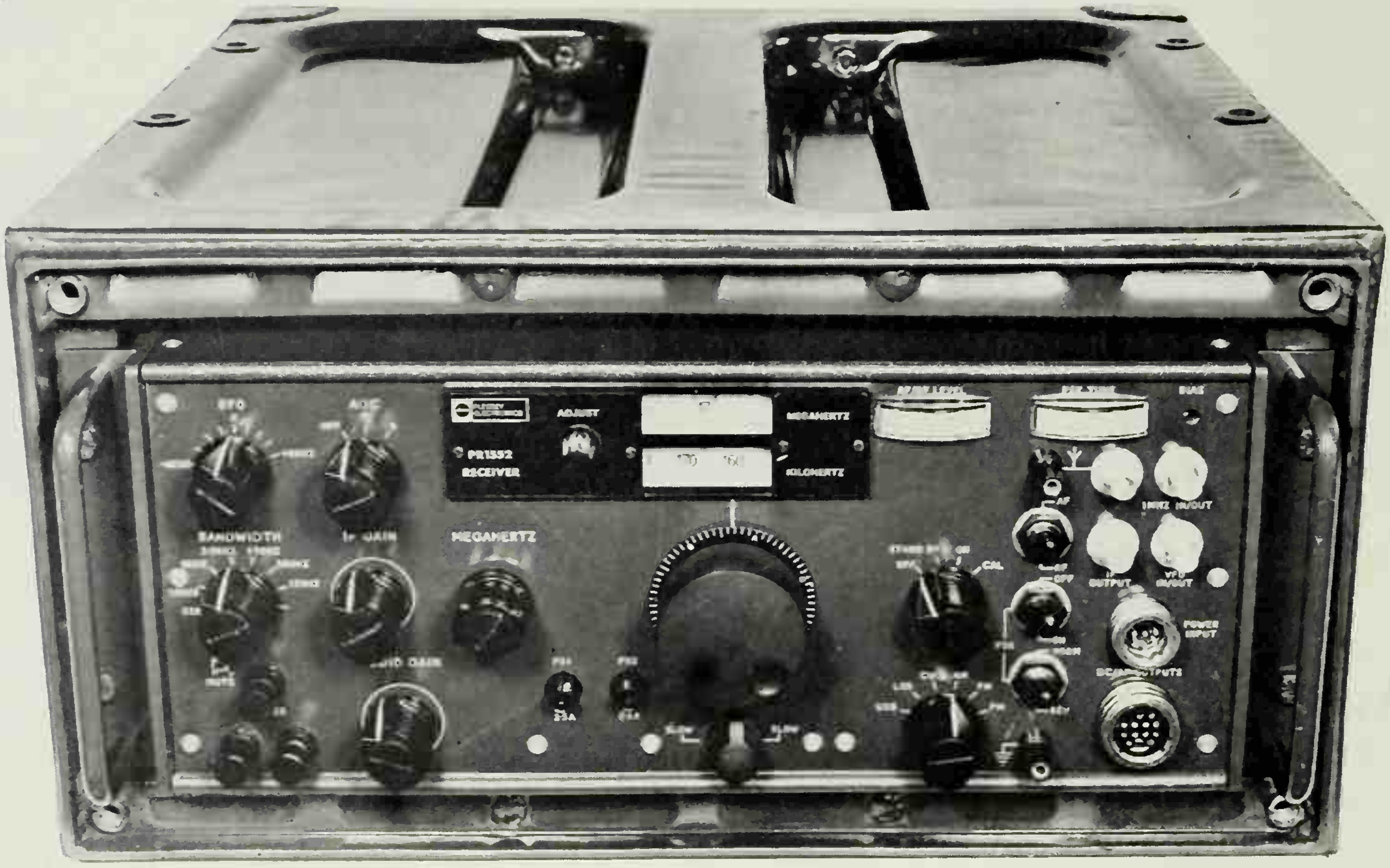


The Plessey UK/PRC 320 high-frequency single sideband manpack station radio mounted on carrying harness. The unit can also be mounted in armoured fighting vehicles and light aircraft

The Plessey PR1552 LF/MF/HF receiver specially designed for military use under the most arduous conditions



HF radio sets

Manpack and vehicle-mounted equipment

Station radio UK/PRC 320

This HF SSB manpack station radio is the most advanced manpack of its type in the world. It represents an entirely new concept in HF SSB manpacks, and provides a complete communications system.

In the design of a manpack a factor of major importance is the total weight and in this respect the set is outstanding. The transmitter/receiver weighs 4·5 kg (10 lb) and a lightweight station with a 24 W/h battery weighs as little as 6·8 kg (15 lb). It is therefore light to wear and permits the full use of weapons. The transmitter/receiver is of rugged construction, very reliable and meets the rigorous requirements of DEF 133.

In the transmitter/receiver a fully synthesised frequency control system is employed using the Plessey microminiature synthesiser. The frequency range is from 2 to 29·999 MHz and the unit has been designed to provide SSB communication. Full AM facilities are available also, together with wide-band and narrow-band CW (300 Hz) capability. Channel spacing is 100 Hz, giving nearly 280 000 channels over the full frequency range.

The unit employs a highly sensitive receiver with a noise figure of 9 dB, and a transmitter which gives 30 W peak envelope power output. Speech processing and automatic level controls ensure that the mean power output is always optimised. Under normal conditions and with 2·4 m (8 ft) whip aerials the set achieves reliable ground communication at ranges in excess of 48 km (30 miles) by day and night. Sky wave range is in excess of 450 km (300 miles) by day and night.

The UK/PRC 320 is a versatile equipment and its role is not confined to manpack usage. A harness adaptor is available which permits the equipment to be used in fighting vehicles. A further example of its versatility is shown by the fact that the equipment can be successfully used in light aircraft.

Specification

Frequency range: 2 to 29·999 MHz
Channel spacing: 100 Hz
Operation modes: SSB, AM, CW wide, CW narrow
Frequency stability: Less than 1 part in 10^6 all causes for six months
Battery: 24 V, 75 W/h, giving 12 hours' operation (assuming transmitter/receiver duty cycle 1 : 9)

Transmitter
Minimum power output: 30 W p.e.p. SSB, 7·5 W AM, 22·5 W CW
Spurious outputs: at least 40 dB below wanted output

Receiver
Sensitivity (o/c levels for 20 dB S/N ratio): 1·7 µV SSB, 7·5 µV AM, 0·6 µV CW
Selectivity: 2·9 kHz SSB, 6 kHz AM, 300 Hz CW narrow
Image rejection: better than 55 dB; IF rejection: better than 60 dB

Mechanical
Weight (excluding battery): 4·5 kg (10 lb)
(including battery, carrier, audio gear and antenna): less than 9 kg (20 lb)
Dimensions (excluding battery): 31·75 × 20·96 × 8·89 cm (12·5 × 8·25 × 3·5 in)
(including battery): 45·72 × 20·96 × 8·89 cm (18 × 8·25 × 3·5 in)
Reliability: approximately 1000 h mean time between faults under the most arduous field conditions

PR 1552 LF/MF/HF receiver

The outstanding features of the Plessey PR 1552 receiver are precise tuning and ease of operation, combined with high stability and wide frequency range. The PR 1552 is a ruggedised LF/MF/HF communications receiver specifically designed for military use. Maximum reliability has been the first consideration and to this end the latest developments in solid-state circuitry have been incorporated. Modular construction is employed to permit ease of servicing and a strengthened chassis/panel assembly has been designed to withstand the military environment. Fast two-knob tuning covers the range from 15 kHz to 30·1 MHz. Crystal calibration points are provided at 100 Hz intervals and interpolation between these points gives better than 100 Hz resolution. Oscillator design ensures stability better than 5 Hz short-term, and better than 100 Hz long-term. High resetting accuracy, minimum intermodulation, cross modulation and spurious radiation are outstanding characteristics of this receiver.

Specification

Frequency coverage: 15 kHz to 30·1 MHz, continuous tuning
Modes of reception: CW (A1), MCW (A2), DSB (A3, A3H), USB LSB (A3A A3J, A3H), FM, PhM and FSK
Frequency stability: After 5-hour warm-up in steady ambient not more than 30 Hz drift
Temperature co-efficient: approx 30 Hz per °C
Frequency change due to 10% input supply variation: not more than 2 Hz
Selectivity:

Filter	6 dB point	60 dB point	Shape
150 Hz	> 150 Hz	< 1·8 kHz	Symmetrical
300 Hz	> 300 Hz	< 3·0 kHz	,,
1·4 kHz	> 1·4 kHz	< 5·5 kHz	,,
3·5 kHz	> 3·5 kHz	< 12·0 kHz	,,
6·0 kHz	> 6·0 kHz	< 18·0 kHz	,,
12·0 kHz	> 12·0 kHz	< 36·0 kHz	,,

SSB mechanical filter 3·0 kHz; shape factor 1·8 : 1
Sensitivity: SSB 10 dB 0·5 µV emf; CW 20 dB 0·5 µV emf; AM 10 dB 2·5 µV emf
Deviation for FM, FSK shift: 6·5 MHz max, 100 Hz to 900 Hz with keying speeds up to 120 bauds
Power requirements: (1) 100 V to 125 V, or 200 V to 250V ac 48 to 420 Hz single-phase or (2) 10 V to 15 V or 19 V to 30 V dc positive or negative earth
Power consumption: 20 W at 24 V dc. 40 VA at 50 Hz
Environment: Operation –20°C to +50°C, 95% RH; storage –40°C to +70°C. Complies with Crown Agents' Specification 118 : 1963
Dimensions, including Creeth case: 520 × 267 × 500 mm (20⅜ × 10⅜ × 19¾ in)
Weight: 29 kg (65 lb)

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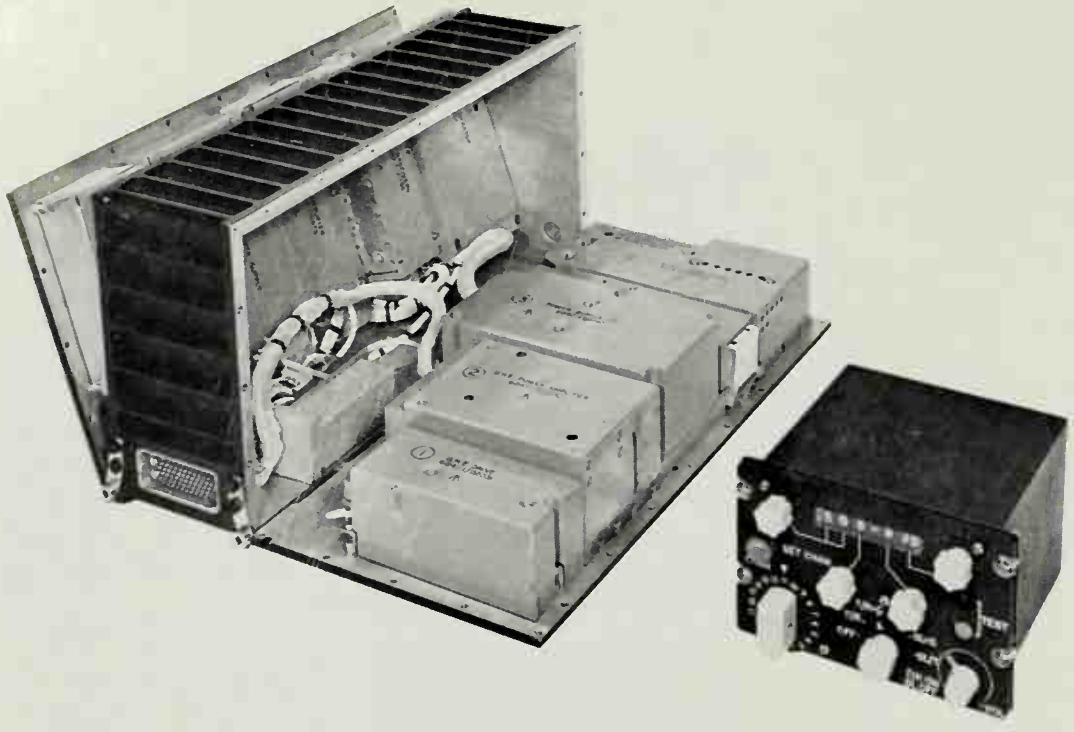
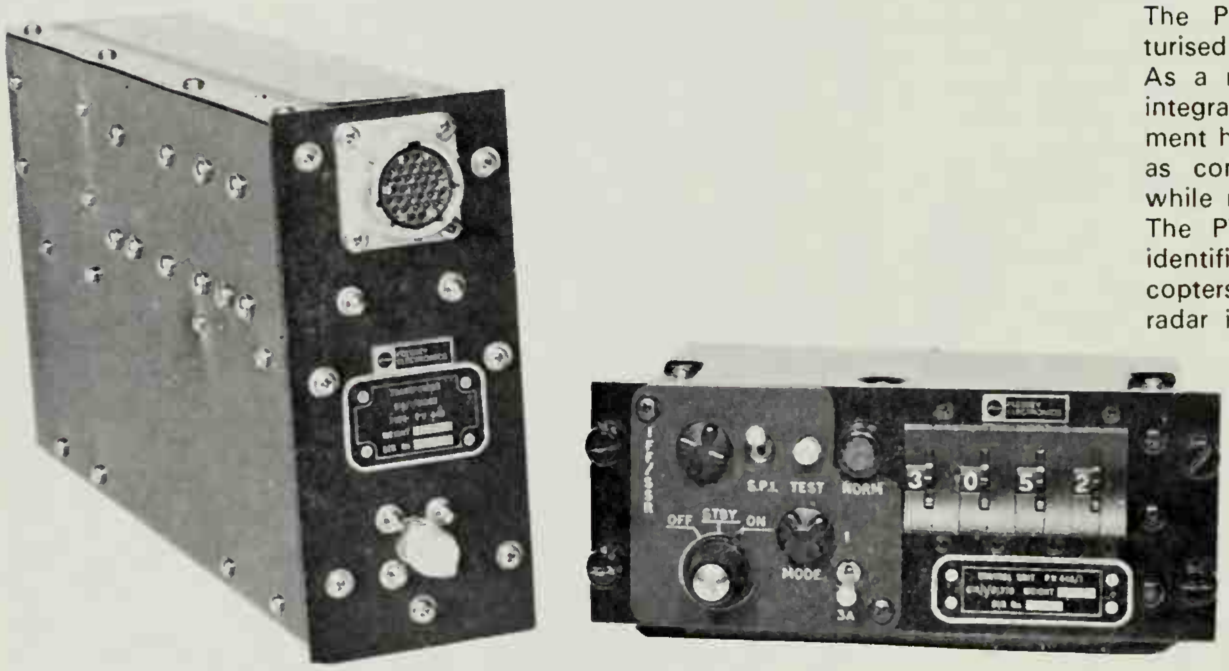


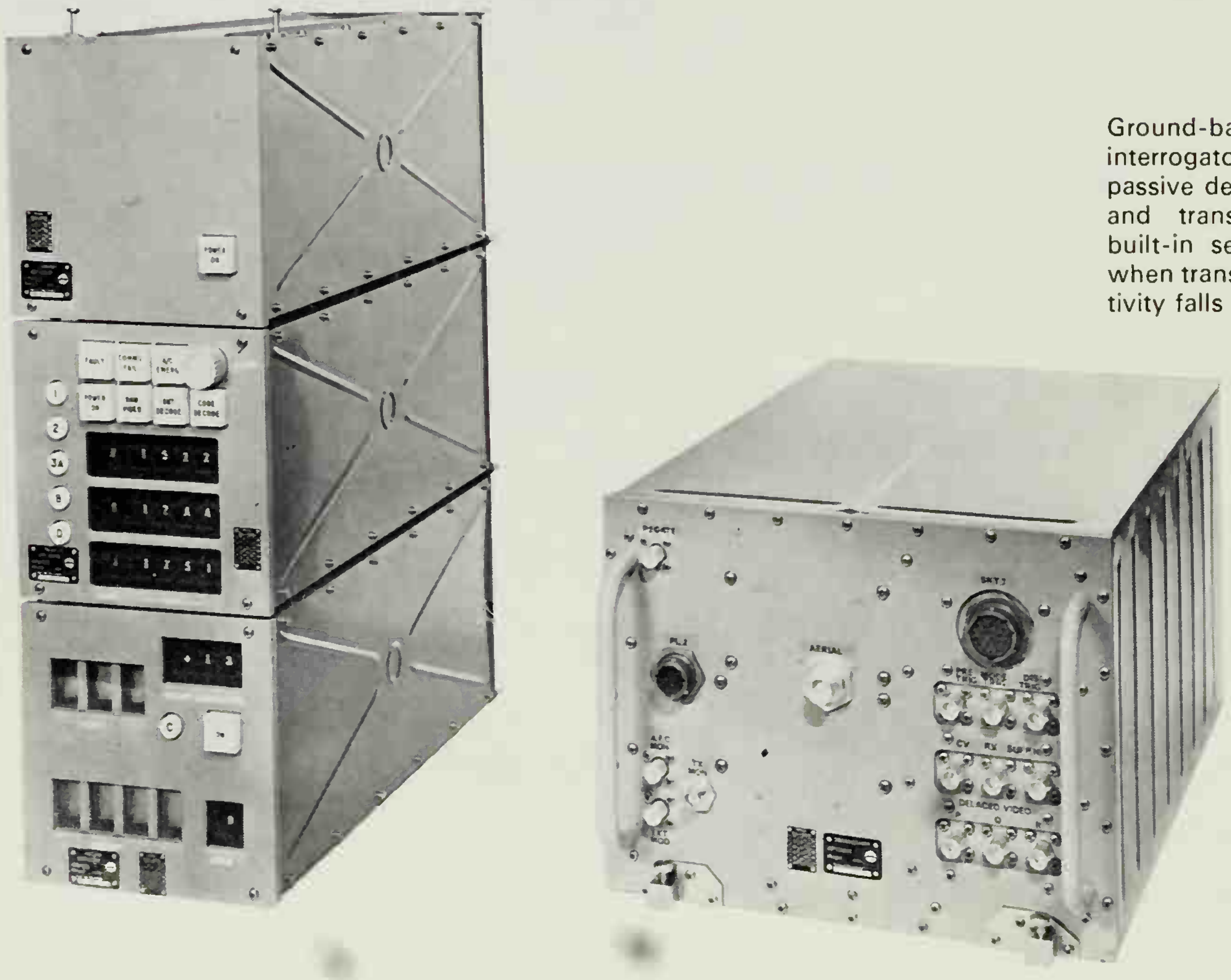
The PTR 377 transmitter/receiver (left) is of modular design. The modules are mounted directly on to the external case of the equipment which carries the cooling fins. The homing, data and guard receiver modules can be removed if they are not required without impairing the operation of the equipment. The control unit is shown at the right

A determining factor in the design of this system has been simplicity of usage coupled with speed of operation. All operating facilities for the PTR 377 are available to the pilot by use of a cockpit-mounted control unit. This control unit provides remote selection of the mode of operation of the transmitter/receiver, and of channel frequency. A memory system is incorporated so that 17 channels can be preset, and there is a transmitter/receiver test facility



The PTR 446 lightweight microminiaturised transponder with its control unit. As a result of extensive use of silicon integrated circuits, the size of this equipment has been reduced by a factor of six as compared with existing equipment, while reliability has been increased.

The PTR 446 is suited ideally for the identification of light aircraft and helicopters in response to ground-based radar interrogation



Ground-based equipment of the Plessey interrogator, with common decoder, passive decoder and active decoder (left) and transmitter/receiver (right). The built-in self-test facility indicates failure when transmitted power or receiver sensitivity falls below preset level

Miniature UHF/VHF radio

transmitter/receivers, transponders and interrogators

PTR 377 airborne transmitter/receiver

The PTR 377 is a combined UHF/VHF general-purpose airborne transmitter/receiver of extremely advanced design operating over the 100–156 MHz and 225–400 MHz bands. The system provides for RT communication on AM, data transmission on fsk, homing in azimuth on both UHF and VHF together with tone transmission for direction finding and emergency purposes. Channel spacing is at 100 kHz for data, 25 or 50 kHz preset or switchable for RT. Any one of the 9240 channels can be selected directly on the remote control unit by means of decade selection knobs. Alternatively, single-switch selection of 19 preset channels anywhere in the range is provided. Two of the frequencies would be the international distress frequencies of 121·5 MHz and 243 MHz, which can be monitored constantly. A completely independent 'guard' receiver is incorporated in the equipment together with self-test facilities. Intercommunication facilities are available between crew members, together with an airborne relay capability using an identical transmitter/receiver. An optional remote frequency-readout facility is available to the pilot by a small cockpit-mounted unit.

With the exception of the UHF power amplifier the equipment is all solid-state and has no moving parts. Solid-state switching is employed together with digital frequency synthesis, single crystal reference oscillator, receiver tuning using varactors, IF selectivity by crystal filter and transfluxor magnetic store for the preset channels. All frequencies are derived from a single highly stable crystal-controlled source. The resultant frequency stability over the temperature range from –55 °C to +70°C permits operation on 25 kHz channel spacing up to 400 MHz.

Frequency range: UHF 225–399·95 MHz; VHF 100–156 MHz
Manual control: Direct selection of any one of the 9240 available channels
Preset channels: Any 19 within the UHF/VHF bands
Channel spacing: 100 kHz for data, 50 kHz or 25 kHz preset or switchable for RT
Carrier power: UHF 20 W minimum; VHF 10 W minimum
Modulation: AM, A2 or A3; FM 20 kHz deviation up to 5 kilobaud data speeds
Frequency accuracy: Maximum error, after 90 sec warm-up less than 7·5 kHz; after 5 min warm-up less than 2·5 kHz
Audio output: Not less than 150 mW into 50 ohms with RF input of 3 μV modulated 30% at 1000 Hz
Sensitivity: 10 dB (S + N)N output for an input signal of 3 μV emf modulated 30% at 1000 Hz
Radio relay operation: Available between UHF/UHF, UHF/VHF or VHF/VHF
Aerial matching: Separate wideband aerials for UHF and VHF with nominal impedance of 50 ohms
Microphone input: Suitable for both low or high level, with or without polarising current
Power supplies: 28 V dc nominal or 400 Hz 3-phase
Consumption: 140 W receive, 400 W transmit
Built-in test facilities: Confidence check on receiver sensitivity, transmitter power, modulation depth
Temperature range: –55°C to + 70°C
Altitude: 30 500 m (100 000 ft) approximately

PTR 446 lightweight IFF transponder

The PTR 446 microminiaturised transponder is one of a new generation of specially developed IFF/SSR airborne transponders for aircraft identification in response to ground radar interrogation.

Alternative military versions of the transponder include higher power equipments covering all modes, and an ability to operate continuously at 30 500 m (100 000 ft) and 90°C ambient.

An outstanding feature of this transponder is its small size and low weight, and it is therefore suited ideally for installation in helicopters and light aircraft. Substantial numbers have been ordered by the British Ministry of Technology.

The PTR 446 consists of a transmitter/receiver and a control unit. The decoder, encoder and associated switches are located in the control unit thus substantially reducing the weight of connecting cables. The operational capability of this equipment covers the selection of any two modes for 1, 2, 3A and B; mode C facility is also provided.

Self-test facilities are incorporated to provide a manual check on receiver sensitivity, transmitter power, mode performance on all modes and code performance on a special test code; an additional test facility indicates the faulty unit.

Transmitter power output: 500 W peak pulse
Pulse rate: 1200, 15 pulse replies per second
Triggering sensitivity (min): –72 to 80 dBm. Signals more than –22 dBm and 20 MHz off tune are ignored

Environmental characteristics
Altitude: 10 700 m (35 000 ft)
Vibration: BS 2G 100, Part 2, Clause 218, Grade B
Temperature range: Transmitter-Receiver unit: –35°C to +70°C; contro unit: –35°C to +55°C

Dimensions and weights
Transmitter-receiver unit: 127 × 57 × 248 mm (5 × 2¼ × 9¾ in); weight 1·67 kg (3 lb 11 oz)
Control unit: 57 × 146 × 102 mm (2¼ × 5¾ × 4 in); weight 0·48 kg (17 oz)

Power requirements
Power supply: dc input 24 to 29 V (BS 2G 100)
Power consumption: 45W

Interrogators

A series of microminiaturised interrogators has been designed for air, ground and shipborne use. Integrated circuit techniques are employed resulting in high efficiency, increased reliability, and in a considerable reduction in both weight and size.

The equipment is designed to interrogate on modes 1, 2, 3 A, B, C and D from an internal encoder. Modes are selected by the control unit, or the modulator can be triggered by an external pulse train. Passive and active decoding is to customers' requirements.

The bulky and temperature-dependent delay lines used for encoding and decoding in current interrogators are replaced in this equipment by silicon integrated circuits using digital shift register techniques. The use of these techniques ensures that the accuracy of pulse spacing from the encoder, and pulse-position acceptance of the decoder, are mode-dependent only on the frequency stability of a crystal-controlled clock pulse generator.

Interrogator transmitter
Frequency: 1030 MHz ± 0·5 MHz
Power output: nominal 5 kW, capable of operation up to 10 kW
Max duty cycle: 0·135%
Pulse length: 0·8 microsec ± 0·1 microsec

Encoder/decoder
Facilities can be supplied to customer's requirements

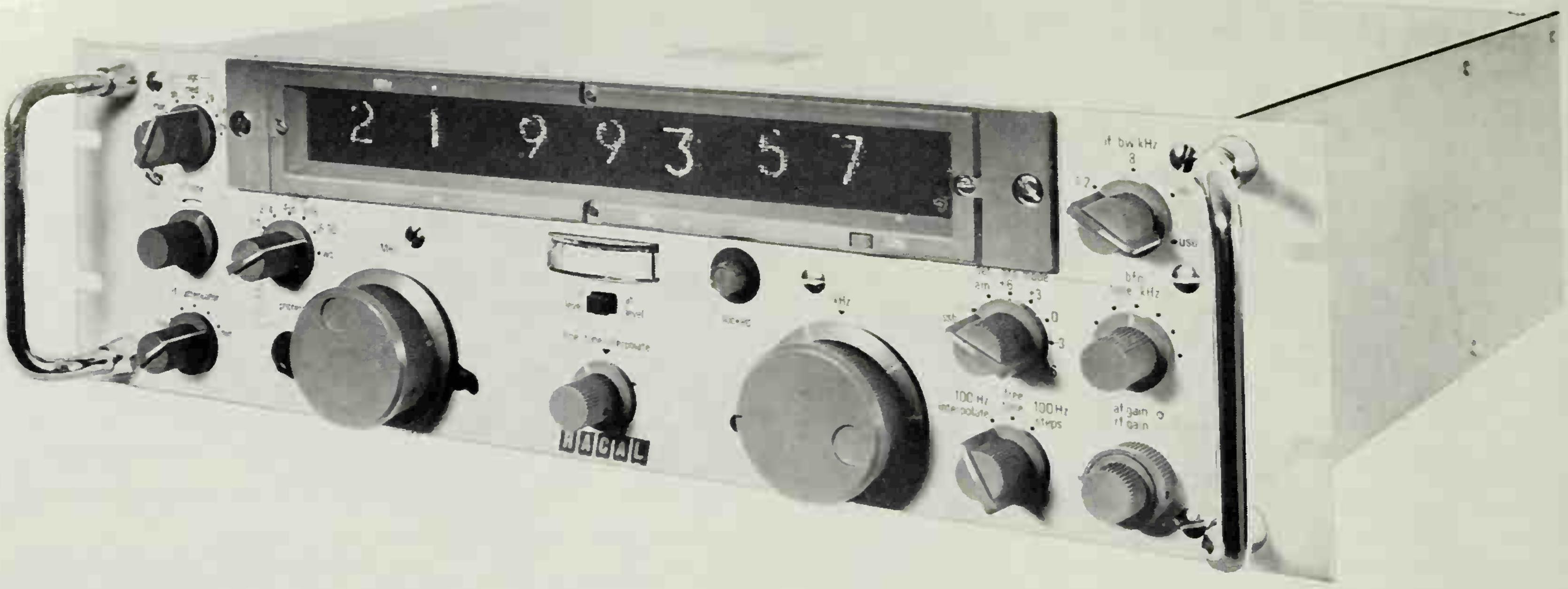
Interrogator receiver
Frequency: 1090 MHz
Sensitivity: –81 dBm for tangential noise conditions
Synamic range: 60 dB
IF amplifier: 60 kHz logarithmic
IF bandwidth: 11 MHz at 3 dB points
Video output: 0·75 V minimum
Pulse rejection: pulses with a width not compatible with IFF signals are rejected

Environments
Temperature range: airborne T/R –55°C to +70°C; ground T/R –10°C to +55°C

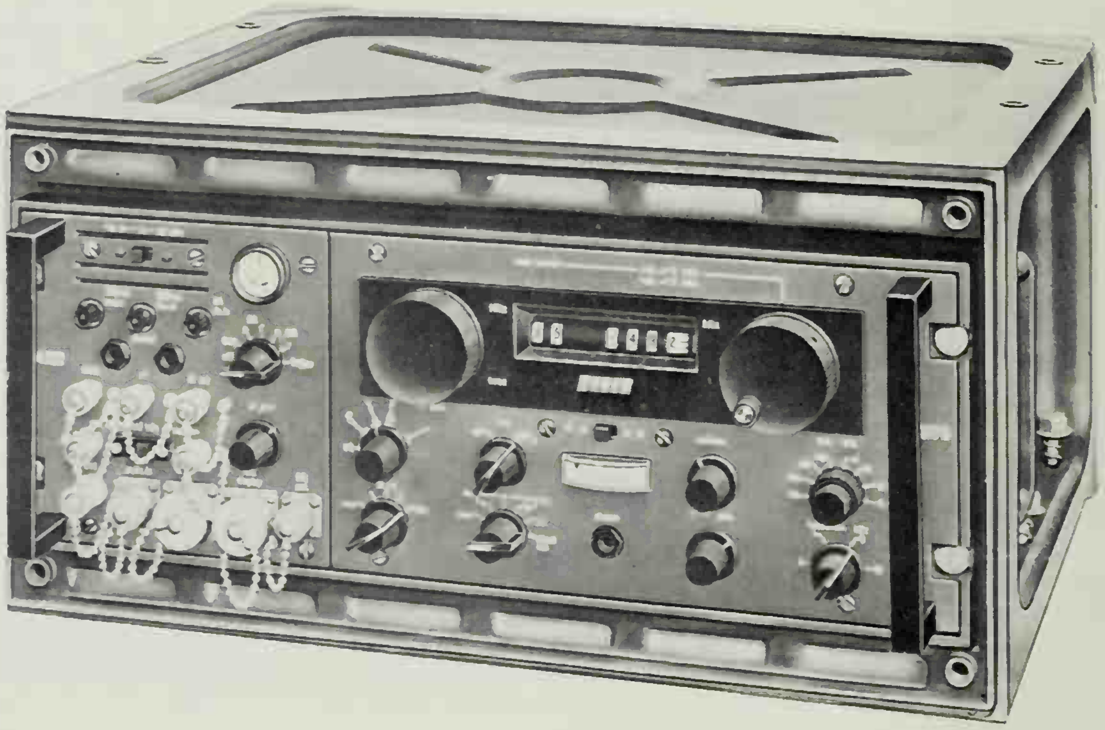
Dimensions and weight
Airborne T/R: size ¾ ATR, 11·3 kg (25 lb)
Control unit: 95 × 146 × 54 mm (3·75 × 5·75 × 2·125 in), 0·9 kg (2 lb)
Encoder/decoder: size ¾ ATR, 5·3 kg (12 lb)
Ground T/R: 432 × 275 × 212 mm (17 × 10·8 × 8·33 in), 19·7 kg (43·5 lb)
Ground decoders: 381 × 153 × 153 mm (15 × 6 × 6 in), common decoder 7·5 kg (16·5 lb), passive decoder 9·2 kg (20·3 lb), active decoder 6·2kg (13·6 lb)

THE PLESSEY COMPANY LIMITED
Electronics Group
Vicarage Lane, Ilford, Essex, England
elephone: 01-478 3040   Telex: 23166

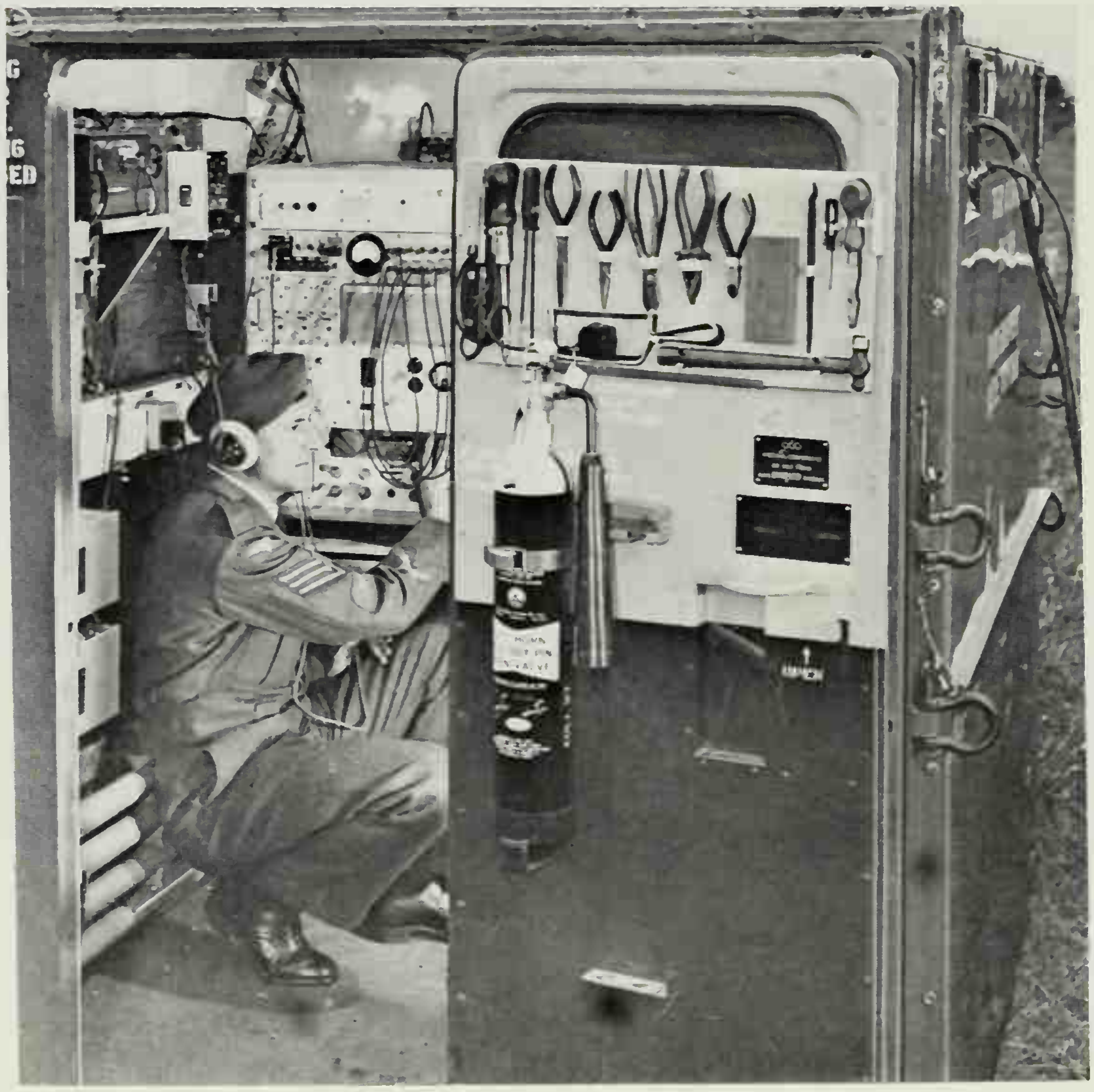
1969



The Racal RA.1220 is the latest in the RA.1217, RA.1218 series of solid-state communications receivers. Modular in construction, it is fully transistorised and incorporates electronic frequency measurement with an eight-digit display. The RA.1220 provides phase-locked operation, with 1 in 10^7 stability, or free-tuning



Suitable for mobile or portable operation, the Racal RA.329B is a fully transistorised, high-stability receiver housed in a military waterproof Creeth case. It provides for fsk, tsk, ssb, FM, PhM, dsb and CW reception in the 1 to 30 MHz frequency range



The illustration shows a typical Racal transportable military receiving communications system. The frequency range is 1 to 30 MHz. Suitable for dsb, ssb, isb, CW, MCW and fsk operation, the entire system is designed to rigid military specifications

Radio equipment

static, transportable, and mobile

RA1220 transistorised HF communications receiver

The RA.1220, the latest in the Racal RA.1217, RA.1218 series of communication receivers, covers the 1 to 30 MHz frequency range and combines the proven merit of the Wadley drift-cancelling system with the Racalok phase-locked frequency stabiliser. Incorporating a digital frequency counter with a built-in frequency standard, it provides a frequency stability to ±1 part in 10^7. While in operation Racalok allows the user to lock the receiver to any frequency within the operating range in discrete steps of 100 Hz, or to interpolate over ±100 Hz intervals. When Racalok is switched out of circuit, conventional free tuning over the full frequency range is available. The latest electronic counting techniques, using silicon integrated circuits, are employed in the measurement and eight-digit in-line display of frequency to ±1 Hz.

Demodulation facilities are provided for ssb (upper or lower sideband), cw, dsb, and mcw. Adaptors are available for isb, fsk, VLF/LF/MF and panoramic reception.

Specification

Sensitivity (tuned input mode):
  SSB and CW: typical 1 μV emf for 15 dB signal-to-noise ratio in 3 kHz bandwidth
  DSB and MCW (30% modulated at 400 Hz): typical 3 μV emf for 15 dB signal-to-noise ratio in 3 kHz bandwidth
SSB filter characteristics: typical response: 3 dB points at +400 Hz and +3000 Hz; 60 dB points at −400 Hz and +3800 Hz. Carrier rejection: −25 dB. Unwanted sideband rejection: −60 dB
Cross-modulation: for a wanted signal level up to 1 mV and with appropriate use of the antenna attenuator, an interfering signal 20 kHz removed and modulated 30% at a level of 45 dB above that of the wanted signal will, in general, produce cross-modulation of less than 3%
Intermodulation: to produce an equivalent 1 μV input, the level of two equal unwanted signals greater than 10% removed from the wanted frequency will be typically 80 dB above 1 μV in the tuned input mode
Blocking: for levels of wanted signal up to 1 mV and with appropriate use of the attenuator, an interfering signal 20 kHz removed will be 56 dB above the level of the wanted signal to reduce its output by 3 dB
Power supplies: 100–125 V or 200–250 V 45–400 Hz single-phase ac
Dimensions: 135 × 483 × 483 mm
Weight: 22·9 kg
Environmental conditions: operation −5°C to +50°C; storage −40°C to +70°C

RA329B military HF communications receiver

Designed for military use, the RA.329B is a compact, portable, fully transistorised high-stability receiver covering the 1 to 30 MHz frequency range. In service with British forces, the RA.329B is capable of demodulating telegraph signals with frequency shifts between 85 Hz and 850 Hz and operating speeds of up to 150 bauds. Operation is also possible in tsk, ssb, AM, CW, FM or PhM with adaptors and ancillary units permitting frequency extension down to 3 kHz, isb, operation and synthesiser control. The equipment is ruggedly constructed, and suitable for use in severe environments. Plug-in modules are used extensively to facilitate maintenance.

Specification

Tuning: digital presentation in units of 1 kHz with interpolation calibration at 200 Hz intervals
Calibration accuracy: better than ±1 kHz referred to nearest 100 kHz calibration point
Frequency stability: after two hours from switch-on: ±50 Hz over an eight-hour period
Sensitivity: CW/SSB: 1 μV (emf) for 15 dB signal-to-noise ratio; MCW/DSB (30% modulated at 400 Hz): 3 μV (emf) for 15 dB signal-to-noise ratio
Selectivity: IF bandwidths of:
1. 13 kHz
2. 3 kHz
3. 1 kHz
4. 0·2 kHz

Power supply: 100–125/200–250 V ac, 45–400 Hz 9–30 V dc
Dimensions: in transit case 270 × 500 × 495 mm
Weight: including transit case with lid 40 kg (90 lb) approx

Military communications system

This lkW communication system is an example of the systems planned, designed and manufactured by Racal. These are assembled from existing units of the Racal range, to provide systems tailored to customer's requirements, having transmitter powers from one to ten kilowatts, all possible modes of operation being available. Receiving equipment is also provided by the standard Racal range, including adaptors for extension of frequency range to cover 3 kHz to 30 MHz, for panoramic or diversity reception. Terminal equipment, data modems and signal-conditioning equipment can be incorporated. Units are suitable for inclusion in simplex or duplex, static, transportable, or mobile installations. Complete remote control of all facilities or of selected facilities is available with or without revertive check. A comprehensive range of antennas and ancillaries is available, enabling manual, automatic and/or remote control facilities to be included in the selected antenna system, which can be designed and supplied to suit any particular requirement.

Systems have already been supplied in quantity to the Royal Navy and Royal Air Force, and to the armed forces of many other countries and organisations, including NATO, Canada, Finland, Eire, Malaysia, Portugal, Turkey and the USA. Many of these have been mobile or transportable systems, generally of 7/10 kW output.

Racal can also supply HF/DF systems, multiple-frequency monitoring systems, and many other specialised communication systems for military use. Where non-standard units are required by the system envisaged, special units can be designed and manufactured.

Other communication products of Racal
Complete communication systems; communications receivers for all modes of operation; transmitters, linear amplifiers and exciters; full range of adaptors and ancillaries; remote control systems; radio-telephones; antenna systems; telegraph and telephone terminal equipment; portable transmitter/receivers and manpack equipment; specialised electronic systems; selective calling and privacy systems; frequency synthesisers; wideband matching transformers. Data transmission and processing; high-speed data transmission systems; high-speed tape recording systems.

RACAL-BCC LIMITED
Western Road, Bracknell, Berkshire, England
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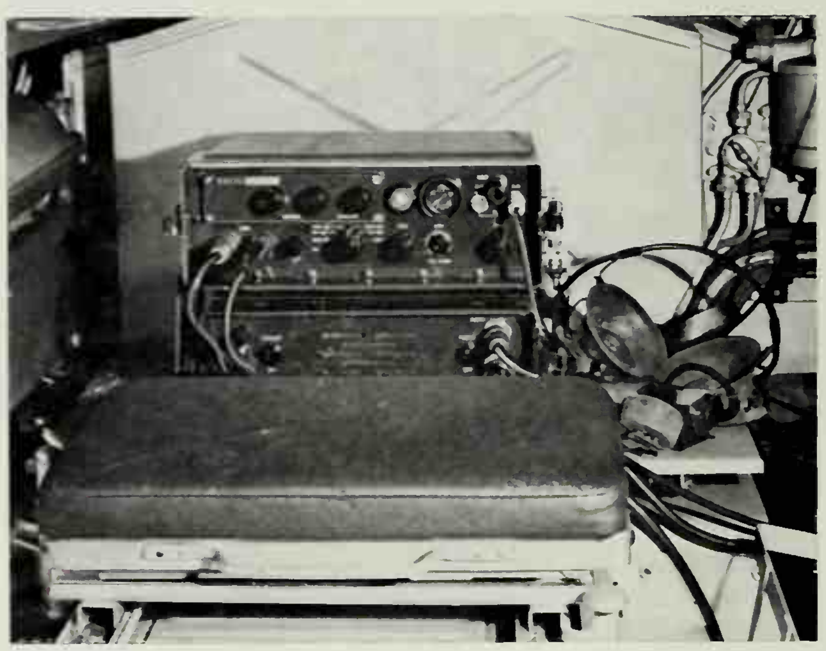
RACAL

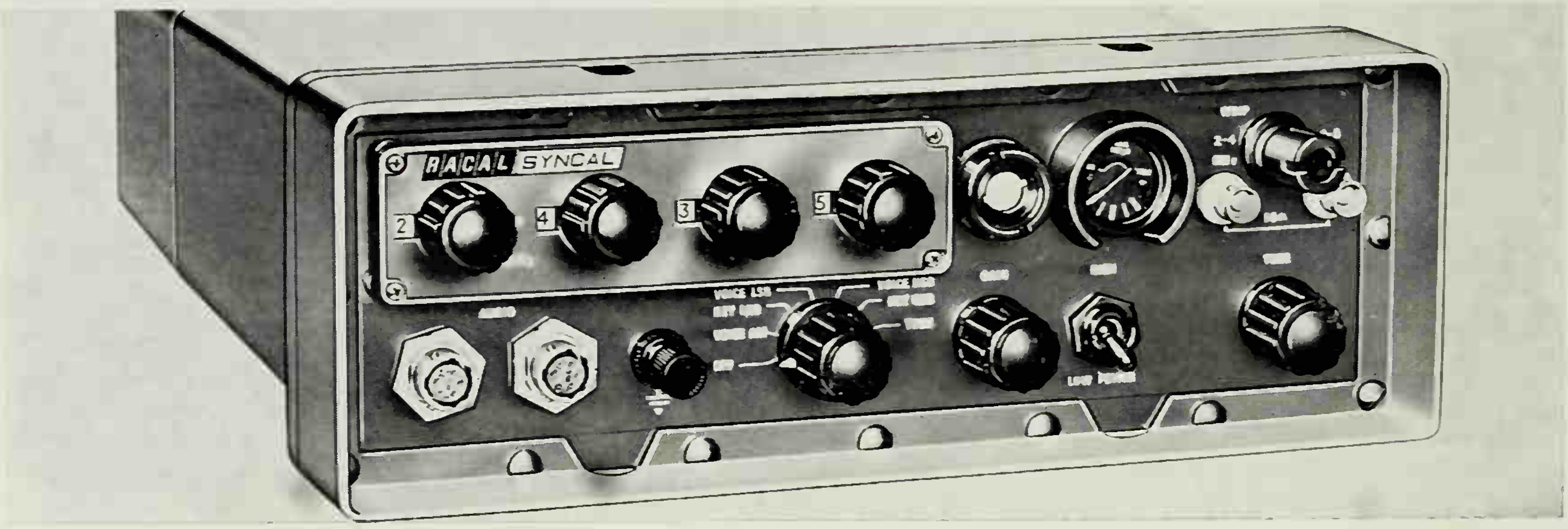
The lightweight TRA.6929 'Minical' provides high reliability in ssb manpack communications under the most severe operational conditions

The TRA.906 'Squadcal' is in world-wide use and can be found operating in vehicles, ships and aircraft, as well as in the manpack role



TRA.922 'Comcal' equipment fitted in a Ferret scout car

Below: the 6000 channel TRA.921 'Syncal' front panel layout makes for extremely simple and rapid operation



Radio equipment

Man-portable equipment for field use

'Minical' HF ssb manpack transceiver

The Racal TRA.6929 Minical six-channel ssb manpack is designed to meet both military and para-military requirements. It covers the frequency range from 2 to 9 MHz, with a radiated output of 1 W p.e.p.

The lightweight Minical is completely sealed, giving extremely reliable performance under the most severe conditions. Simplicity of operation not only allows for rapid change of frequency etc, but also permits unskilled personnel to learn to use the set effectively. A wide range of accessories is available, all interchangeable with other Racal-BCC manpacks, keeping logistic support requirements for this and other Racal-BCC based systems at a minimum, with consequent savings in overall operating costs.

Specification

Power output: 1 W p.e.p.
Frequency range: 2 to 9 MHz
Number of channels: six
Antennas: 1·8 m (6 ft) overall whip or dipole (using coaxial adaptor)
Antenna matching: single control using internal ATU
Sensitivity: 1 mV for 15 dB signal-to-noise for 1 mW AF output
Intermodulation distortion: –25 dB relative to 1 W p.e.p. output
Power consumption, ssb speech: 150 mA at 12 V for 1 W p.e.p. output
Sealing: sealed and fitted with a desiccator. Battery container removable without breaking main seal
Dimensions (with battery case): 190 × 760 × 210 mm (7·5 × 3 × 8·25 in)
Weight: basic unit 1·2 kg (2·75 lb) complete manpack with handset, antennas batteries and haversack 3·6 kg (8 lb)

'Squadcal' lightweight transistorised HF, ssb manpack

Developed to meet world-wide military requirements for a low-cost, light and reliable ssb HF manpack, the Squadcal TRA.906 is a fully-transistorised, HF, ssb equipment with 29 crystal-controlled channels in the 2 to 7 MHz frequency range.

The TRA.906 has had outstanding world-wide success and is in operation in large numbers in more than 60 countries. With controls kept to a minimum (for instance a single control changes frequency) operating parameters may be changed in a matter of seconds. The wide range of accessories available allows operation in vehicles, ships and aircraft or as fixed station.

Specification

Power output: 5 W p.e.p.
Frequency range: 2 to 7 MHz
Number of channels: 29
Antennas: whip, dipole, end-fed wire or long wire
Antenna matching: single control using internal ATU
Sensitivity: 1 mV for 15 dB signal-to-noise for 1 mW AF output
Intermodulation distortion: –25 dB relative to 5 W p.e.p. output
Power consumption, ssb speech: 550 mA at 18 V
Sealing: sealed and fitted with desiccator. Battery container removable without breaking main seal
Dimensions: 312 × 111 × 394 mm (12·25 × 4·35 × 15·5 in)
Weight: operational manpack 8·2 kg (18 lb)

'Comcal' crystal-controlled HF ssb manpack

The TRA.922 is a highly stable, dustproof, waterproof and immersible manpack providing 49 crystal-controlled channels in the 2 to 8 MHz range, with extremely reliable performance under rigorous environmental and operational conditions. It can operate ssb on either side-band, with AM and CW facilities also available. The built-in antenna tuning unit matches transmitter and receiver to whip, long wire or dipole antennas.

Specification

Power output: 20 W p.e.p.
Frequency range: 2 to 8 MHz
Number of channels: 49
Antennas: 2·4 m (8 ft) whip, long wire or dipole
Antenna tuning: single control using internal ATU
Sensitivity: 1 mV for 15 dB signal-to-noise for 2 mW AF output
Intermodulation distortion: –25 dB relative to 20 W p.e.p. output
Power consumption, ssb speech: 1·5 A for ssb average speech
Sealing: sealed and fitted with a desiccator. Battery container removable without breaking main seal
Dimensions: 312 × 111 × 394 mm (12·25 × 4·35 × 15·5 in)
Weight: basic unit 4·1 kg (9·25 lb), complete manpack with handset, antennas batteries and haversack 9·8 kg (21·5 lb)

'Syncal' synthesiser-controlled HF, ssb manpack

Fully-transistorised, the TRA.921 Syncal provides 6000 channels at 1 kHz spacing between 2 and 8 MHz, using simple frequency-setting and mode controls. It is a low-cost, lightweight equipment developed for military requirements, providing extremely reliable operation under the most severe conditions. The Racal-BCC wide range of ancillaries, interchangeable with those for other Racal-BCC manpacks, permits operation in vehicles and boats as well as in fixed-station roles.

Specification

Power output: 20 W p.e.p.
Frequency range: 2 to 8 MHz
Number of channels: 6000
Antennas: whip, dipole or long wire
Antenna matching: single control using internal ATU
Sensitivity: 1 mV for 15 dB signal-to-noise for 1 mV AF output
Intermodulation distortion: –25 dB relative to 20 W p.e.p. output
Power consumption, ssb speech: 1·5 A
Sealing: sealed and fitted with desiccator. Battery container removable without breaking main seal
Dimensions: 312 × 111 × 394 mm (12·25 × 4·35 × 15·5 in)
Weight: operational manpack 10·0 kg (22·25 lb)

RACAL-BCC LIMITED
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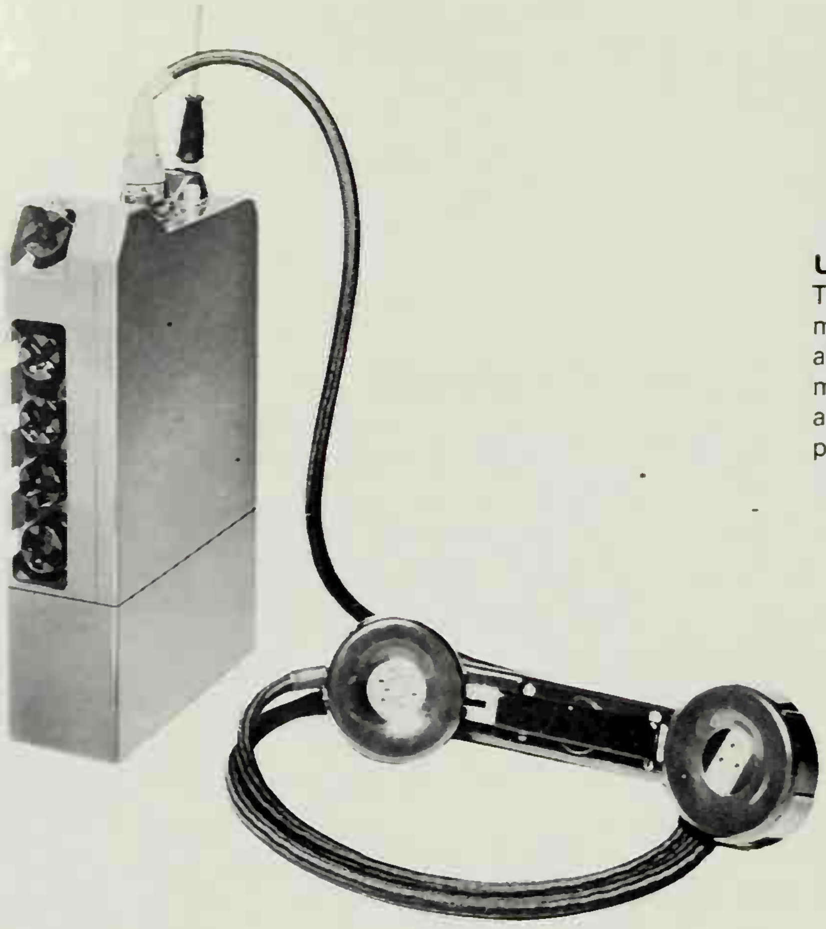
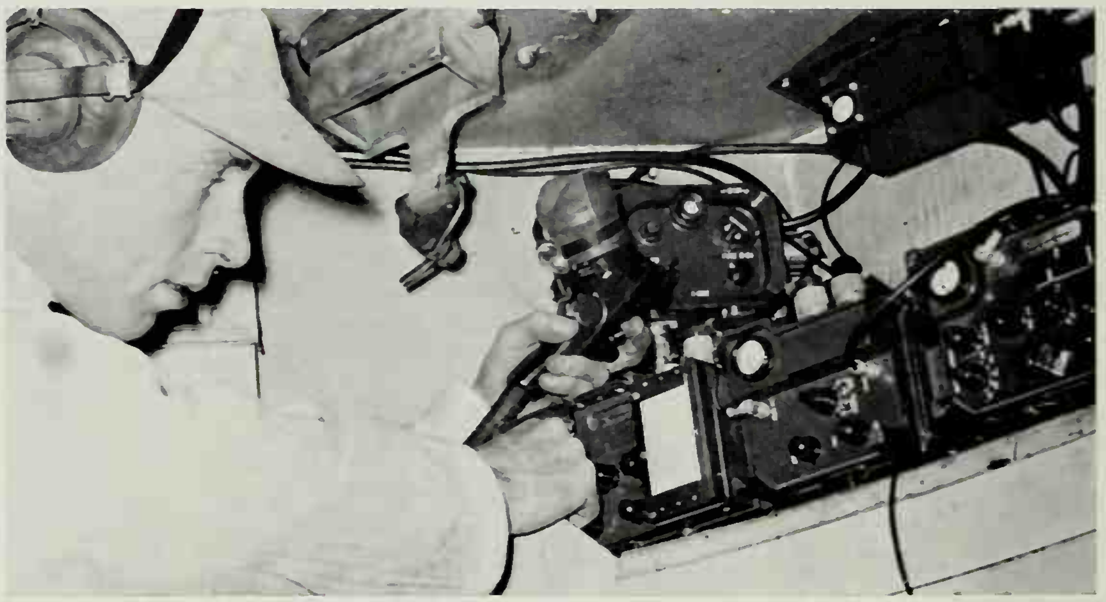
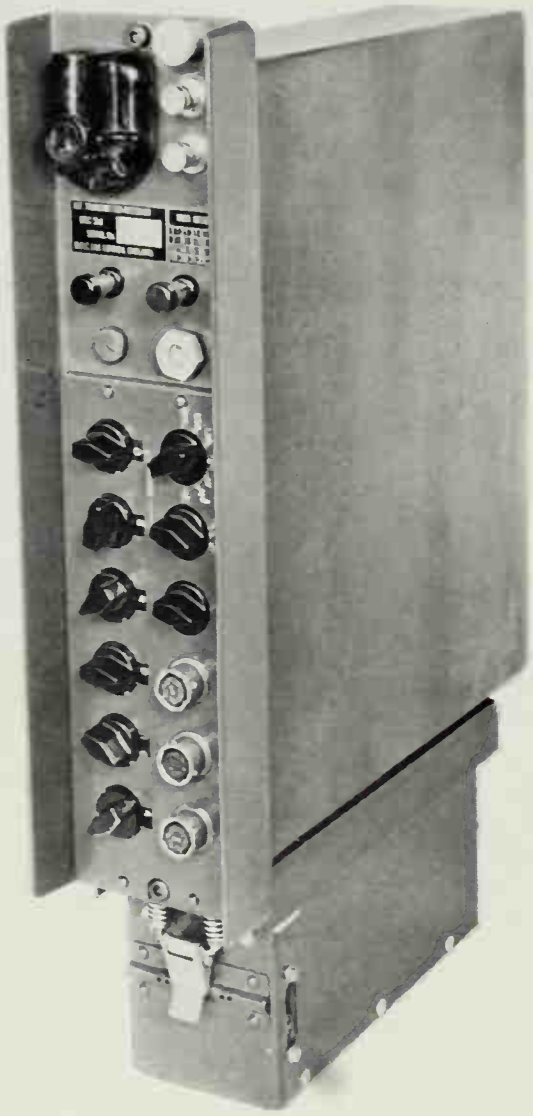
RACAL



UK/PRC350
The UK/PRC350 is a very small, lightweight VHF/FM military manpack which can operate on any one of 840 channels, spaced at 25 kHz, over the 36 to 57 MHz range. With 2 W p.e.p. transmitter output it has a reliable ground-wave range of 5 km and, as with all Clansman equipment, can operate over the temperature range from −40° to +50°C

The SR A14 as a permanent installation. The adaptor unit on which the set is mounted incorporates a transistorised converter supplied from the vehicle battery, eliminating the need for the normal set batteries





The BCC34 is undoubtedly the most advanced HF ssb combat radio available anywhere in the world. It is all-solid-state design, ensuring maximum reliability under the most rigorous climatic and combat conditions. Frequency selection is rapid, with a built-in synthesiser forming the nucleus of the frequency selection system. Versatile in application, the BCC34 can work in the cramped environment of a fighting vehicle as effectively as it can operate as a manpack or in a static role.

Lightweight manpacks

also suitable for semi-static duties

SR A14

The SR A14 is a fully-transistorised high-power pack-set in service with the British Army, the Royal Navy and the armed forces of 15 other nations.

The SR A14, known to the Royal Navy as Type 635/2, provides PhM, AM and CW facilities and has a ground range of some 40 km (25 miles). Used as a fixed station working into a wire aerial, the standard man-pack can be used to communicate over distances of hundreds of miles.

The SR A14 complies with DEF 133 L3 and is engineered to provide reliable communication under the most adverse environmental or combat conditions.

A low-powered version is available known as the BCC30 LP with a range of about 13 km (8 miles) between man-carried sets.

Clansman VHF FM manpacks

Clansman is a new system of battle-zone communication for infantrymen, armoured vehicles, gun and missile batteries, beach landings, parachute drops and ground air links. The two Clansman VHF manpacks UK/PRC350 and UK/PRC351/352 are the most advanced in the world. These fully synthesised equipments, each smaller and lighter than other manpacks of comparable power, are designed to meet the needs of the highly mobile troops of the 1970s.

The UK/PRC350 and UK/PRC351/2 offer an integrated VHF system for forward-area communications for service anywhere in the world. High reliability is coupled with simple operation. The small number of controls designed for use by a gloved thumb enables virtually unskilled personnel to operate the equipment.

Flexibility

Although the equipments described are basically manpacks they are both extremely versatile. A wide range of accessories, enables them to be used as semi-static ground stations, vehicle installations, or shipborne equipment. Additional facilities are available for remote aerial siting, remote control, and completely self-supporting ground stations using hand-operated or petrol-driven generators.

Specifications

SR A14

General

Type of operation: single-frequency simplex voice and CW
Modulation: amplitude and phase
Frequency range: 2–8 MHz
Channels: 18 crystal-controlled plus full free tuning
Power supplies: 12 V nickel-cadmium rechargeable batteries
Battery life: receive 85 h, transmitter high power 6 h
Weight: SR A14 16·4 kg (36 lb); BCC30LP 10·7 kg (23 lb)
Overall dimensions:
  SR A14: 412 × 114 × 293 mm (16¼ × 4½ × 11½ in)
  BCC30LP: 278 × 114 × 293 mm (11 × 4½ × 11½ in)
Operating temperature range: −31 to +52 C plus 100%rh

Transmitter

RF power output (PhM and CW): SR A14: 20–30 W; BCC30LP: 1·5–3·0 W
Frequency stability: drift does not exceed −2·9 kHz and +0·5 kHz over full temperature range

Receiver

Frequency stability: drift does not exceed −1 kHz and +3 kHz over full temperature range
Selectivity: +3 kHz at −6 dB (min) ±10 kHz at −65 dB (max)
Sensitivity: for 14 dB minimum signal-to-noise ratio at 30% modulation depth: 4μV (emf) on PhM, 6·3 μV (emf) on AM and 2 μV (emf) on CW

UK/PRC350

Operation: narrow-band FM ±5 kHz deviation
Frequency range: 36 to 57 MHz, 840 channels, 25 kHz spacing
Frequency stability: better than 5 in 10^6
RF output: 2 W
Receiver sensitivity: 1 μV emf for 10 dB signal-to-noise ratio
Facilities: remote operation, whisper facility, battery extension connector for arctic conditions
Power supply: 15 V primary or secondary batteries
Size/weight: 23 × 12 × 6 cm (9 × 5 × 2¼ in) 2·7 kg (6 lb) including battery

UK/PRC351/352

Operation: narrow-band FM ±5 kHz deviation
Frequency range: 30 to 76 MHz, 1840 channels, 25 kHz spacing
Frequency stability: 5 parts in 10^6
Facilities: local, remote, re-broadcast and intercom. operation, whisper facility
Size: 41 × 23 × 11 cm (16¼ × 9¼ × 4¼ in) including batteries, and set carrier (includes power amplifier for PRC 352)
Weight: PRC351, 5·5 kg (12 lb); PRC352, 8 kg (18 lb); includes ancillaries for normal station; additional battery adds 1·8 kg (4 lb)
RF output: PRC351 4 W, PRC352 10 W
Receiver sensitivity: 1 μV emf for 10 dB signal-to-noise ratio
Power supply: 24 V secondary batteries

Common characteristics PRC350/351/352

Climatic performance: working temperature −40°C to +55°C plus a temperature rise due to effects of solar radiation. Sealed for pan-climatic conditions
Whisper facility: modulation sensitivity increased by 20 bB, AF output reduced by 20 dB
Spurious suppression: ⩾40 dB relative to carrier
AF output/response: 10 mW for 5 kHz deviation; level 0 to 6 dB 300 Hz to 3 kHz referred to 1 kHz
Squelch: automatic squelch provided, operating on 6 dB quieting signal

BCC34

Frequency range: 1·5 to 30 MHz
Number of channels: 285 000 in 100 Hz steps
Modes of operation: single-frequency simplex, usb or lsb at customer's choice, compatible AM, CW (wide or narrow band) fsk available with additional equipment
Frequency stability: ±1 ppm −20°C to +55°C, ±2 ppm −20°C to −40°C
Weight: complete manpack station 10 kg (22 lb)
Temperature range: −40°C to +55°C
Antenna matching and tuning unit, manpack: built-in fully-automatic antenna tuning unit. Vehicle: separate, fully-automatic antenna tuning units available
Battery life (24 V 3·5 Ah nickel-cadmium): 15 h at a 1·9 transmit/receive duty cycle

Transmitter

Power output: high-power 25 W p.e.p., low-power 2 W p.e.p. (*Note*: 100 W p.e.p. output available by using BCC541 linear amplifier)
Intermodulation products: −25 dB (standard two-tone test)
Spurious emissions: −40 dB relative to p.e.p.
Carrier suppression: −40 dB relative to p.e.p.
Unwanted sideband suppression: −40 dB relative to p.e.p.

Receiver

Sensitivity: ssb 2 μV emf for 20 dB signal-to-noise ratio; AM 10 μV emf for 10 dB signal-to-noise ratio
Selectivity: ssb/CW wide 6 dB points 300 Hz and 2700 Hz; AM 6 dB bandwidth 12 kHz; CW narrow 6 dB bandwidth 400 Hz
Image rejection: 70 dB
IF rejection: −60 dB

Optional accessories

BCC13 Mk 2 hand generator, BCC21 petrol generator, BCC501 battery charger for 12 V/24 V supplies, BCC503 battery charger for 110 V/250 V supplies, BCC511 7·5 m (24 ft) lightweight aerial mast, BCC513 remote control kit, remote aerial tuning unit, vehicle installation kits (temporary and permanent) BCC541 100 W linear amplifier for BCC34.

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RACAL

MITRE (Miniature Individual Transmitter/Receiver Equipment) is a pocket-sized unit with a slide-on rechargeable nickel-cadmium battery giving 10–13 hours' continuous use under typical conditions.

It is so light that, when fitted in its harness, it can be worn for long periods without discomfort, leaving both hands free for other tasks. It can also be worn undetected in the pocket for security operations.

The communicator has four preselected crystal-controlled channels suitable for single- or two-frequency simplex operation. Versions suitable for 12·5, 20, 25 or 50 kHz channel spacings are available. The unit is designed with automatic squelching of unwanted channel noise so that the receiver is silent until the incoming signal is received. The signal level can be set and monitored without constant adjustment by a friction-damped volume control.

Servicing of the equipment is facilitated by the single-piece cover which, when removed, gives access to all parts of the unit. Fully transistorised module construction ensures ease of service.

Two standard harnesses are available—one lightweight Terylene, the other all-leather. These harnesses have a dipole antenna concealed in the shoulder strap although special types can be made to suit customers' individual requirements.

Battery chargers can be supplied with either two- or twelve-way quick-slide charging positions. The batteries can be completely recharged in 14 hours but overnight recharging is sufficient after a normal day's usage.

In addition to the standard clip-on loudspeaker/microphone with press-to-talk switch a wide range of accessories can be provided to meet individual requirements. These include boom, throat and miniature microphones, with earpiece or heavy-duty headset.

The PRC-316 was designed and developed by the Signals Research and Development Establishment as a highly reliable transmitter/receiver for long-range patrol operations. Because the set will often be used under arduous conditions by non-skilled operators, equipment operation has been kept to its simplest form and component parts of the basic station kit have been kept to a bare minimum.

The unit is designed primarily for skywave CW communications over distances of hundreds of miles and AM voice communications over shorter distances. It has been specified for use with the UK Armed Services. The equipment carries its own sealed primary battery which plugs into a compartment beneath the set. An integral morse key is provided.

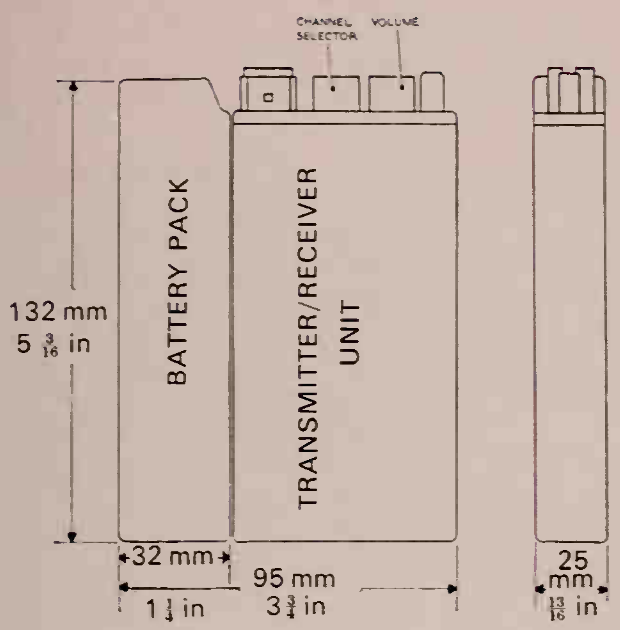
The equipment is rugged, fully water-, dust- and shock-proof and operates under extremes of climate and arduous environmental conditions. Ancillary equipment includes two insulated antenna wires wound on reels together with their throwing cords and a single-transducer headset which incorporates a pressel switch so that it can be used as a microphone for voice communications. The basic station kit complete with carrying bag and battery weighs less than 4 kg (9 lb).

The two antenna wires may be laid on top of small bushes and together form a half-wave dipole with the RT-316 at the centre of the two legs. If the antenna is to be placed very high, a coupler unit and coaxial down-lead can be used. Calibration markers on the antenna wires allow precise matching to channel frequency. The transceiver is fitted with output meter and tuning control. To enable the unit to be used for static duties, it can also be operated from a secondary battery. A battery adaptor, lead and headset with boom microphone are available. This facility makes the RT-316 one of the most versatile sets now available.

Telecommunications

Compact two-way equipment

VHF two-way pocket phone



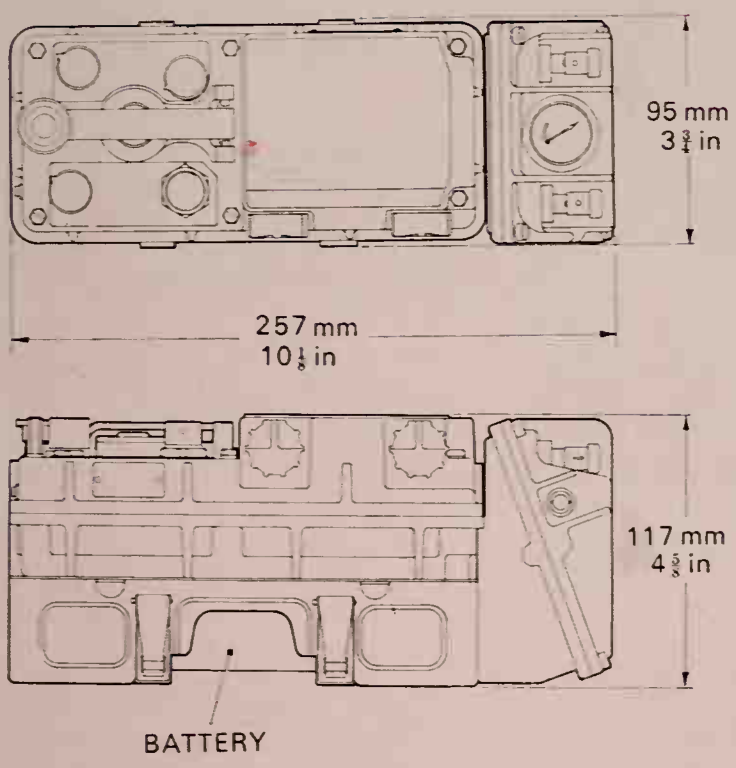
Specification

Service: FM simplex, single- or two-frequency
Frequency: 68–100 MHz or 145–174 MHz
Channel separation: 12·5 kHz deviation ±2·5 kHz; 25 kHz deviation ±5 kHz; 50 kHz deviation ±15 kHz
Channels: 4
Antenna: common Tx/Rx wire dipole
Power supply: 12·4 V nickel-cadmium battery, rechargeable
Endurance (typical): 10–13 h at 5% transmit, 20% receive, 75% standby
Controls: channel/off. Volume. Press-to-talk (on microphone)
Weight: Tx/Rx unit 275 g (9·7 oz); Battery 210 g (7·5 oz)

Transmitter
Power output: 0·5 W in 50Ω, 68–100 MHz; 0·4 W in 50Ω, 145–175 MHz
Frequency stability: carrier frequency is within ±2 kHz of nominal value from −10°C to +40°C
Spurious emissions: to relevant specification
Modulation characteristic: +6 dB/octave from 300 Hz to 3 kHz

Receiver
Sensitivity: 1 μV emf for 20 dB quieting
Signal-to-noise ratio: 15 dB for 1 μV emf
Selectivity: to relevant specification
Frequency stability: 0·002% from −10°C to +40°C
Spurious responses: at least 60 dB down on carrier
Squelch: set to open at 0·8 μV emf
Audio response: −6 dB/octave from approx 300 Hz to 3 kHz
Audio output: 100 mW max

Lightweight HF patrol transceiver



Specification

Frequency range: 2–7 MHz
No of channels: 45 (9 groups of 5 channels spaced at 1·25 kHz within each group)

Type of communication:
  CW narrow band, 300 Hz bandwidth
  CW wide band, 6 kHz bandwidth
  R/T, AM, 6 kHz bandwidth

Range:
  CW: 320 km (200 miles) typical
  R/T: 100 km (60 miles) typical
Both distances can be greatly exceeded, dependent on siting and propagating conditions

Transmitter power output: 4 W (peak)

Battery (primary):
  Type: various
  Voltage: 12 V
  Life: 12–30 h dependent on battery type and at a transmit/receive ratio of 1:9

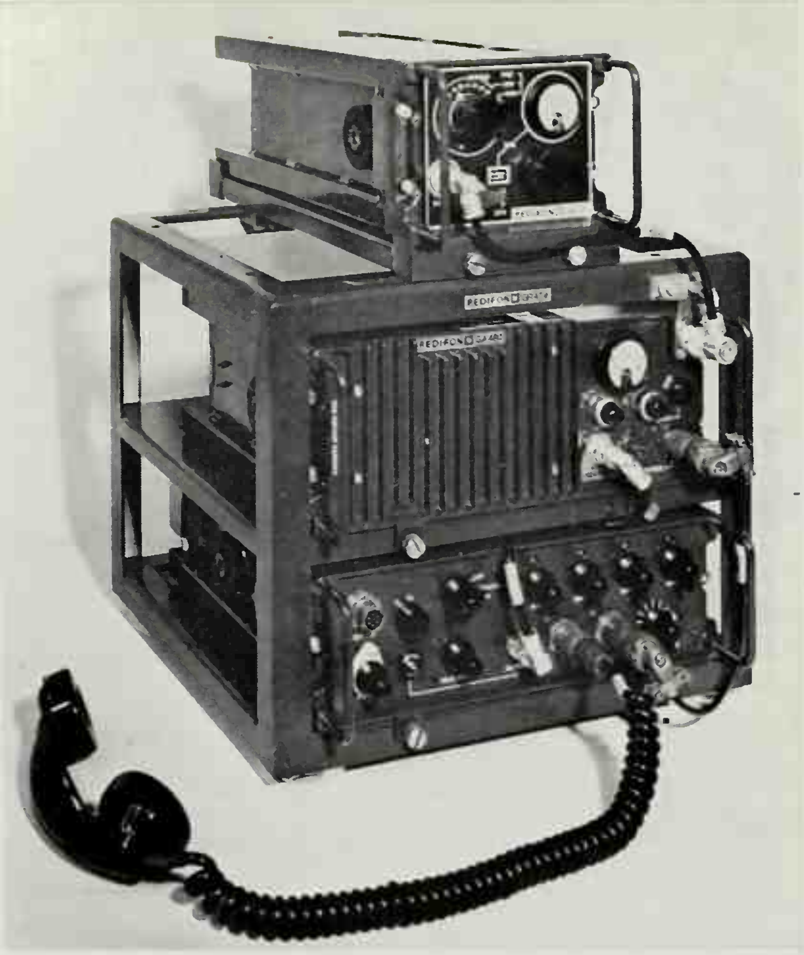
Antenna: ½-wave dipole, centre-fed wire aerial

Dimensions (including battery):
  Length: 257 mm (10⅛ in)
  Width: 95 mm (3¼ in)
  Depth: 117 mm (4⅝ in)

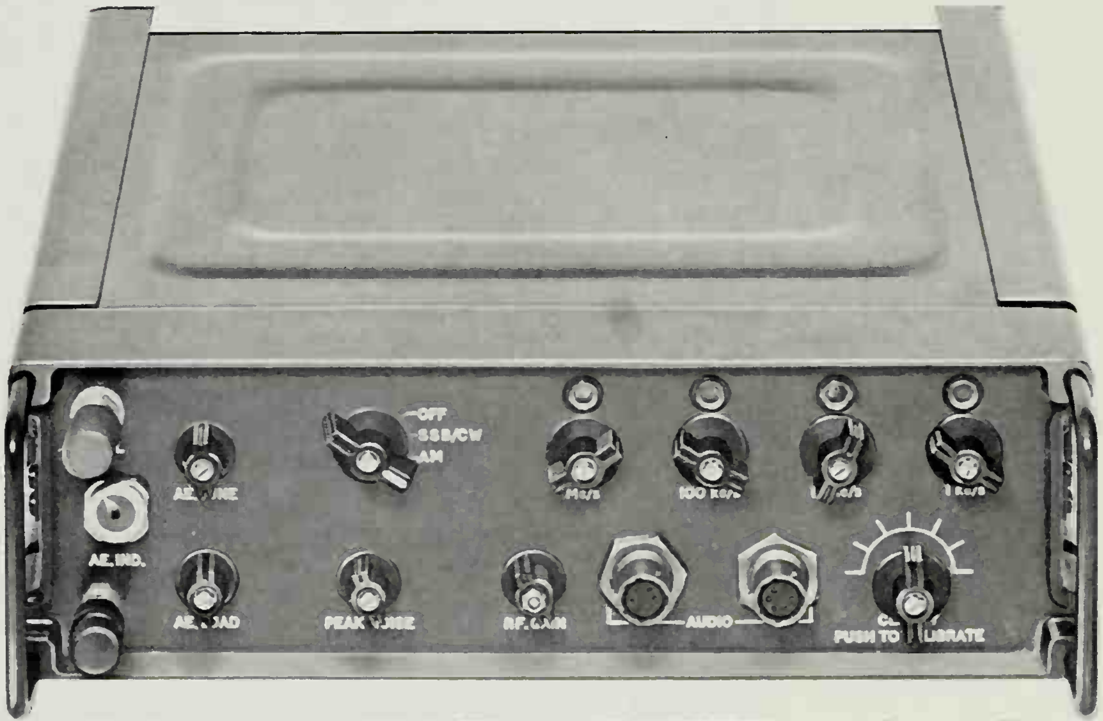
Weight:
  Transceiver: 2·3 kg (5 lb)
  Antenna (2-off): 424 g (15 oz) each (complete with reel and throwing cord)
  Headset (single unit): 226 g (8 oz)
  Battery (primary): 680–900 g (1½–2 lb) dependent on type

Temperature range:
  Operating: −10°C to +55°C
  Storage: −40°C to +65°C
Altitude: 3000 m (10 000 ft)
Relative humidity: 100% up to 35°C

RANK PRECISION INDUSTRIES LIMITED
Broadcast Division
Watton Road, Ware, Hertfordshire, England
Telephone: Ware 3939 Cables: Rank Ware Telex: 81415



GR479B vehicle or transportable 100 W SSB station, complete with aerial coupling unit. No output tuning or loading is required in this all-solid-state equipment, which uses frequency synthesis to provide 9999 channels between 2 and 12 MHz. The equipment can be supplied with a special container to enable the station to be dropped by parachute or manhandled out of a helicopter



The all-solid-state GR345 manpack provides an output of 15 W p.e.p., and uses frequency synthesis to provide 10 000 channels in 1 kHz steps from 2 to 12 MHz. Services: SSB, AM and CW

The GR345 manpack is in service with Royal Marine Commando units on combined operations

Radio equipment

static, transportable and mobile

GR479 100 W peak envelope power SSB/DSB/CW station

Available in several versions, this all-solid-state frequency-synthesised station is ideal for use in vehicles, for which role one version has been adopted by the RAF. It is also particularly suitable for service in small naval craft and armoured fighting vehicles, or it can be readily transported by light aircraft and can be supplied in a container suitable for dropping by parachute.

The GR479 covers the 2–12 MHz range by frequency synthesis in 1 kHz steps, selected by four direct-reading decade switches. The aperiodic linear power amplifier carries no tuning or loading controls; adjustment of the aerial coupling unit for maximum indication on its meter is all that is required to ensure maximum power output to the aerial, while damage cannot be caused by mismatch or even by an open- or short-circuit at the aerial socket.

Front-end protection is provided against inputs of up to 50 V and is effective whether the equipment is switched on or off. This protects the station against powerful signals from nearby transmitters.

Specification

Frequency range
2–12 MHz in 1 kHz steps

Power output
SSB (A3J): 100 W p.e.p.
DSB (A2, A3): 25 W carrier (100% mod)
CW (A1): 100 W

Receive sensitivity
Signal-to-noise ratio of not less than 10 dB for a 1 μV SSB input signal

Power supply
24 V dc (direct from vehicle supply). A power unit is available for ac operation

GR345 15 W peak envelope power SSB AM CW manpack

This lightweight manpack incorporates a frequency synthesiser which generates 10 000 channels in 1 kHz steps from 2 to 12 MHz and permits rapid, direct setting of frequency by four decade switches.

In addition to operating on SSB, the GR345 affords instant selection of double-sideband AM, making the manpack immediately compatible with other AM sets irrespective of their frequency stability. CW service is also provided, and a full range of accessories covers all operational needs.

Specification

Frequency range
2–12 MHz in 1 kHz steps

Modes of operation
A1 (A2J): CW telegraphy (keyed-tone SSB, fully suppressed carrier)
A3: AM telephony (full carrier, plus upper and lower sidebands)
A3J: SSB telephony (upper sideband, fully suppressed carrier)

Power output (transmitter)
A1 (A2J): greater than 12 W
A3: 3·75 W carrier
A3J: not less than 12 W p.e.p.

Power supply
12 V dc rechargeable and non-spillable battery or vehicle supply

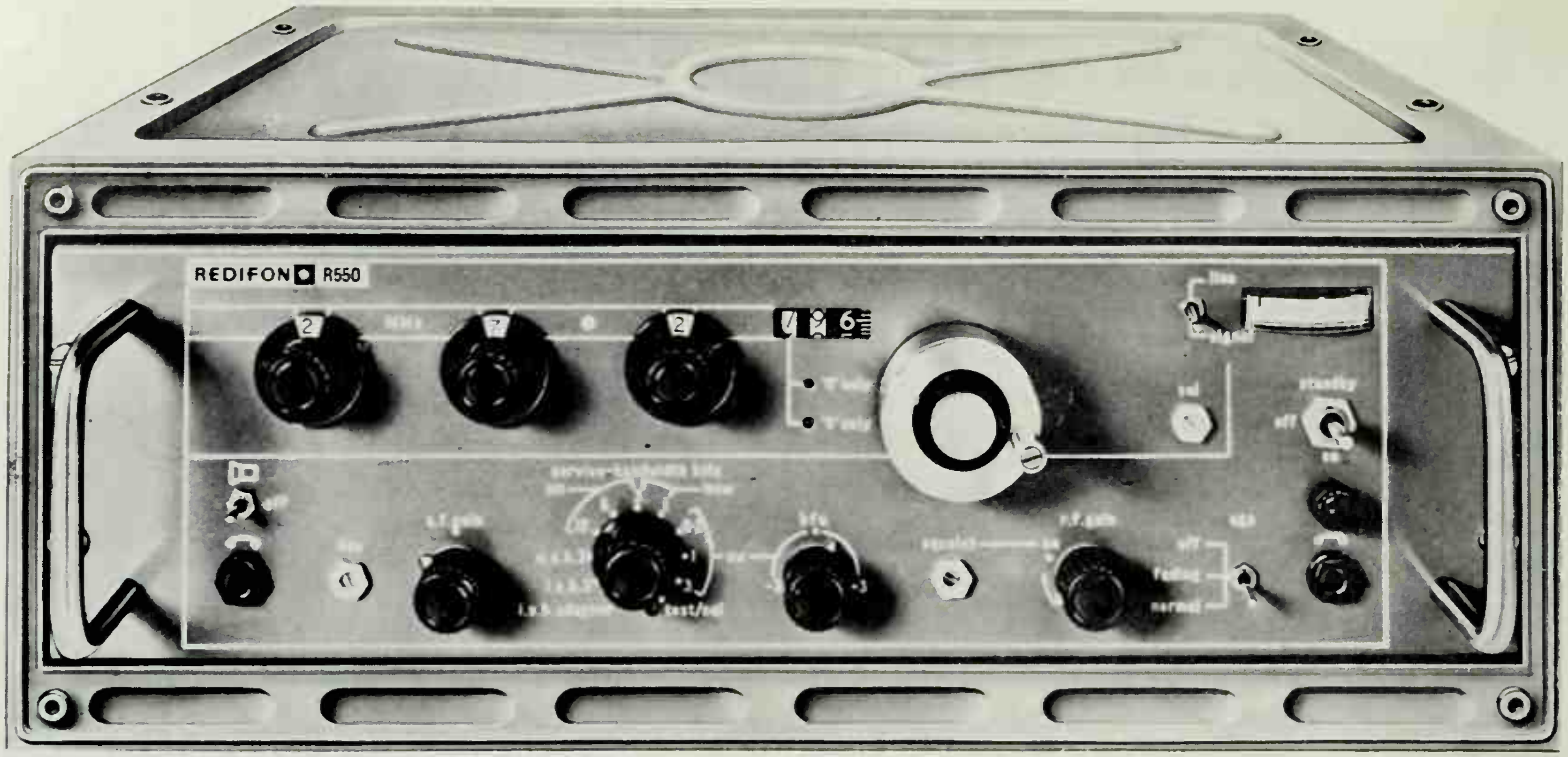
Other Redifon communications products

Military and civil communications systems from VLF to HF; a full range of transmitters, receivers, transmitter drive units and terminal equipment; naval radio teleprinter systems; HF and UHF manpacks; non-directional MF radio-beacons; Omega receivers; error detection and correction devices.

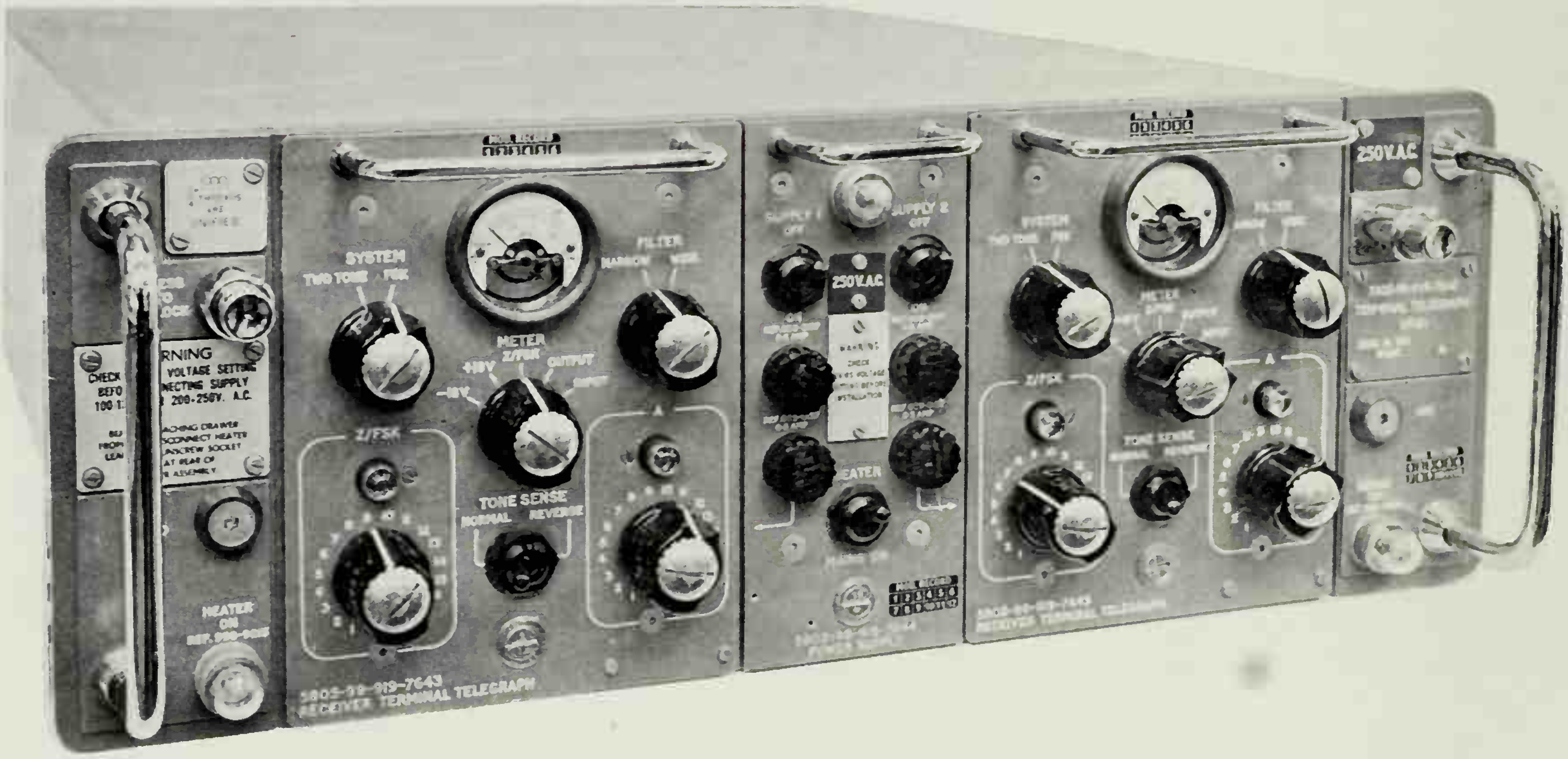
REDIFON LIMITED
Communications Division
Broomhill Road, London SW18, England
Telephone: 01-874 7281 Cables: Redifon London Telex
Telex: 264029

A Member Company of the Rediffusion Organisation

REDIFON


REDIFON R550

The Redifon R550 all-solid-state MF/HF communications receiver with VFO/frequency-synthesis tuning. Operates on CW, DSB, SSB (USB and LSB) with optional add-on units for ISB and for switch selection of full synthesis. 200 kHz —30 MHz


SYSTEM
TWO TONE
FSK
METER
Z/FSK
OUTPUT
INPUT
+18V
-18V
FILTER
NARROW
WIDE
TONE SENSE
NORMAL
REVERSE
250V.A.C
HEATER
HEATER ON
5805-99-919-7643
RECEIVER TERMINAL TELEGRAPH

The TT20 converts a received radio teletype signal, comprising either a two-tone frequency exchange signal or a frequency-shift keyed tone, to a 1 kHz on/off keyed tone or a keyed low-level dc (6-0-6 V) which after further conversion may be used to drive a teleprinter

Radio equipment

for naval and military communications

R550 all-solid-state MF/HF communications receiver with VFO/frequency-synthesis tuning

The R550 provides unbroken coverage from 200 kHz to 30 MHz by frequency synthesis in 100 kHz steps followed by VFO tuning over a 100 kHz band, with a resolution of 10 Hz and fully digital presentation. An optional add-on unit completes the synthesis down to 100 Hz steps, permitting instant selection of VFO or full synthesis.

This flexibility of tuning, together with a dynamic range of over 120 dB and unique inter-coupled agc systems, plus exceptionally good blocking and cross-modulation characteristics, is of particular importance to services in which it is necessary to search congested bands or operate in the presence of very strong adjacent signals—the front end withstands 30 V aerial emf and is protected against damage by higher voltages.

Specification

Sensitivity
On SSB, 1 μV input emf for better than 17 dB signal-to-noise ratio. On CW (above 1 MHz), 0·5 μV input emf for better than 21 dB signal-to-noise ratio

Frequency stability
Short term (30 min): ±6 Hz at 200 kHz to ±14 Hz at 30 MHz after 2-hour warm-up. Long term (8 h): ±12 Hz at 200 kHz to ±20 Hz at 30 MHz, after 3-hour warm-up

Selectivity
3 dB bandwidths (selectable):

CW	200 Hz, 1 kHz, 3 kHz
MCW, DSB	1 kHz, 3 kHz, 6 kHz, 12 kHz
SSB	3 kHz (6 kHz to order)
ISB	2 × 3 kHz (2 × 6 kHz to order)

Noise factor
Typically 5 dB

Cross modulation
For a wanted signal up to 1 mV, and without need for an aerial attenuator, an interfering signal 20 kHz removed (30% mod) and 60 dB above wanted signal will in general produce cross modulation < 3%

Blocking
For wanted signal up to 1 mV, without need for an aerial attenuator, an interfering signal 20 kHz removed must be 75 dB above wanted signal to reduce its output by 3 dB

Power supplies
100/125 V 200/250 V 47/63 Hz. It is possible to operate from a 24 V dc emergency supply

Dimensions
127 × 483 × 380 mm (5 × 19 × 15 in)

Weight
17 kg (35 lb)

Construction
Modular to simplify servicing. Designed to British Defence Specification DEF.133, Class L1, and to meet the vibration test specified in Class L2 (Clauses 8.1A and 8.2A)

TT20 VF telegraph terminal unit for teleprinter installations

Specially designed for the Royal Navy, the TT20 is an interface equipment for use in ship-borne or shore-based teleprinter terminal installations operating over an HF or UHF radio system.

It incorporates twin VF receivers for simultaneous and independent operation, with a common power supply. Each receiver forms part of a single teleprinter channel and accepts either a keyed two-tone frequency exchange, or narrow-band frequency-shift telegraph signal which it converts to a 1 kHz tone (or, for certain applications, to a low-level dc signal). After further conversion this signal is used to drive a teleprinter.

The TT20, which is part of a full range of Redifon terminal equipment for use in naval RATT systems, complies with climatic and durability standards laid down for ship-borne equipment in British Ministry of Defence Specification DEF.133.

Specification

Signal input
1) Any two tones from the following series: (255 + 170n) Hz, where n = 1, 2, 3 16
2) FSK modulation of any one of the tones in (1); deviation ±42·5 Hz or ±25 Hz
3) Two tones, one 700 Hz, the other either 500 Hz or 1000 Hz

Signal output
1) On/off keyed, 2·6 V (maximum) 1000 Hz ±20 Hz (into 600Ω balanced line). Tone on/off ratio not less than 60 dB
2) 6-0-6 V dc (into 1 kΩ load)

Input impedance
600 Ω ±10%, balanced

Power supply
100/125 V or 200/250 V, 50/60 Hz, single-phase

Other Redifon communications products

Military and civil communications systems from VLF to HF; a full range of transmitters, receivers, transmitter drive units and terminal equipment; naval radio teleprinter systems; HF and UHF manpacks; non-directional MF radio-beacons; Omega receivers; error detection and correction devices.

REDIFON LIMITED
Communications Division
Broomhill Road, London SW18, England
Telephone: 01-874 7281 Cables: Redifon London Telex Telex: 264029

A Member Company of the Rediffusion Organisation

REDIFON

Naval radio systems

for shipborne and shore station use

Marconi's comprehensive range of ssb/isb naval communications equipment meets all present and foreseeable requirements for voice and high-speed telegraphy.

The whole range conforms to Royal Navy standards for shock, vibration and climatic conditions and it has been NATO codified by the British Ministry of Defence. It is widely used by the Royal Navy and in the modernisation of more than ten other navies.

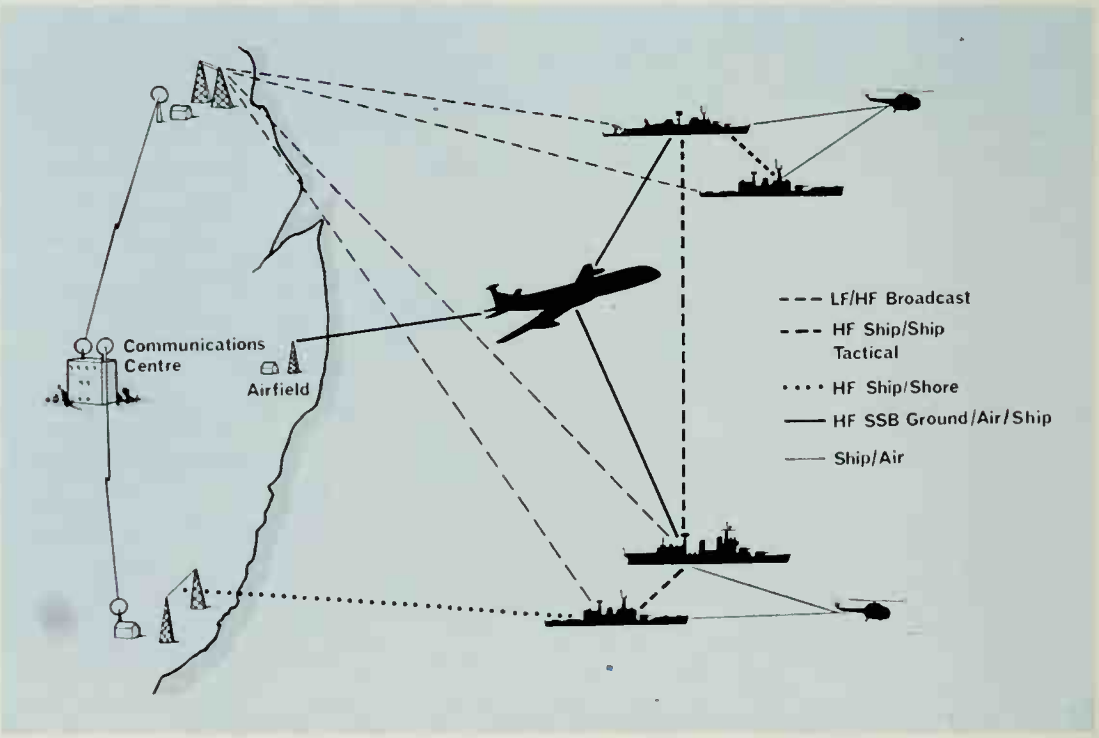
The equipment has been designed for the greatest flexibility of installation and to provide maximum power at the transmitting aerials. Provision is made for operating facilities to be extended to any position via the ship's control system.

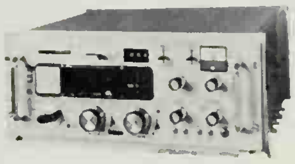
Marconi Communication Systems Limited has a complete range of communications equipment available for shore stations; shipborne, mobile and static space communications; airborne communications, and digital transmission equipment.

In addition the company is able to assist naval departments and shipbuilders with the planning, fitting, testing and tuning of complete ship installations.

100 W HF transmitter H1030

An all solid-state transmitter with digital 1 Hz-step read-out and self-contained master oscillator with a stability of ±1 part in 10^7. Meets full military requirements. Services A1, A2H, A3A, A3B, A3J.



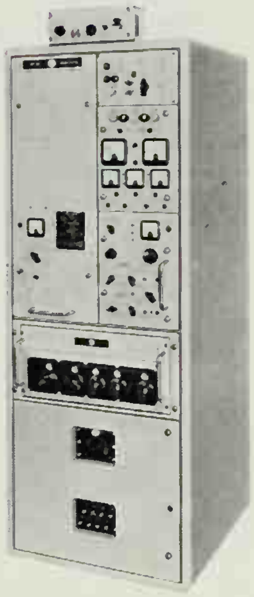


HF communications receiver H2310

Tuning accuracy to within 1 Hz with long-term frequency stability. Frequency range 10 kHz to 30 MHz and suitable for most operating modes. Good rf and if selectivity.
The H1030 can be mounted on top of H2310 for compact siting.

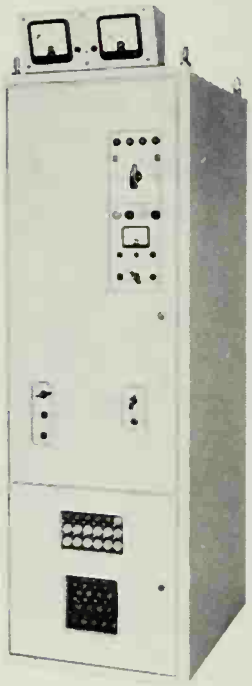
ISB receiver N2020

Suitable for telegraphy or telephony reception in the MF and HF bands. Will accept CW, dsb, ssb, isb and fsk. Frequency synthesiser operates from high-stability external 1 MHz standard. Operates without transmitted pilot tone.



500 W broadband ISB transmitter NT204

Air-cooled, embodying frequency synthesiser primary drive and an intelligence drive system covering whole MF/HF maritime frequency range. No tuning required. Services: CW or MCW telegraphy; dsb or ssb/isb telephone; fsk telegraphy.



1 kW broadband linear RF amplifier NT203 and NT203/1

No tuning required and ideal for unattended operation, with provision for remote control. Frequency coverage: 1·5–24 MHz (NT203) or 240 kHz–24 MHz (NT203/1).

MARCONI COMMUNICATION SYSTEMS LTD
Radio Communications Division
Marconi House, Chelmsford, Essex, England
Telephone: Chelmsford 53221 Cables: Expanse Chelmsford Telex: 99201

Radio transmitter

1 kW HF general-purpose unit

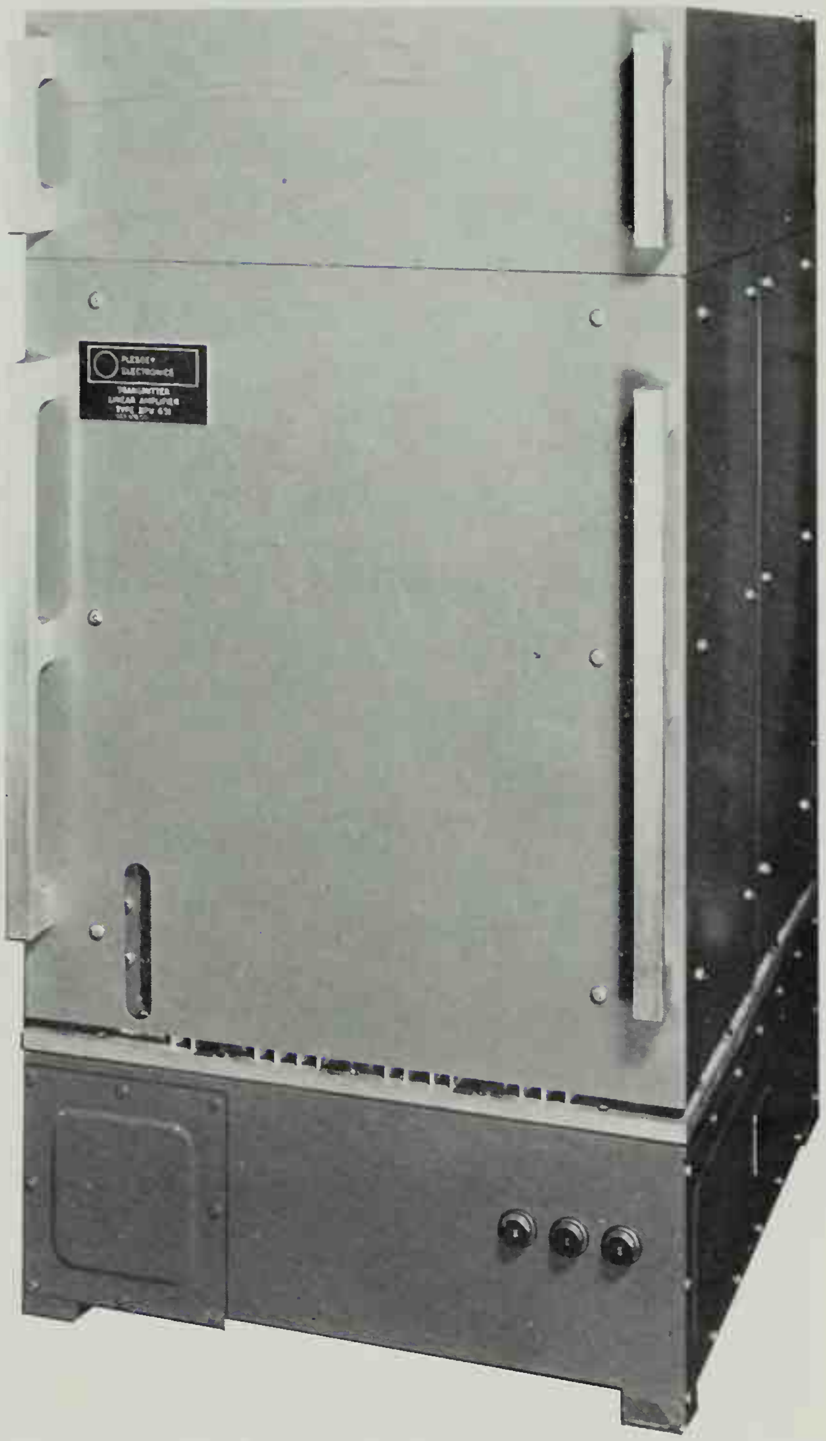
The PVT650 is a general-purpose 1 kW self-tuned transmitter which covers the frequency range from 2 MHz to 30 MHz. It is intended for point-to-point, ground-to-air, high-speed mobile operations or in an air-transportable role in either a civil communications or a military environment.

The transmitter has been designed to provide low operational cost, high reliability and flexibility for system planning. It is suitable for multi-mode operation. and the overall bandwidth of ±6 kHz permits multi-channel speech and telegraph transmissions. Frequency changes are accomplished in less than 30 seconds. Completely automatic tuning facilities, coupled with a high degree of reliability, render the equipment eminently suitable for operation by unskilled personnel, and provision is made within the transmitter for the inclusion of full remote control. With the exception of the final stage, solid-state techniques are used.

The PVT650 transmitter comprises a PV652 drive unit, a PV651 linear amplifier and an optional PV653 remote-control system. The transmitter can be operated either locally, with extended control up to 200 m (630 ft), or remotely using a single telephone channel via a cable or radio circuit. Spare capacity is provided for the control of ancillary equipment.

The PV652 drive unit can be mounted with the transmitter or it can be rack-mounted elsewhere. Many built-in system facilities in the basic equipment cost include 100 kHz outlets, spare remote-control functions and supply voltage stabilisation.

The radio-frequency output amplifier and its associated power supply unit employ evaporative cooling. An inert fluorocarbon liquid is used to transport surplus heat from the components to an air-cooled heat exchanger. This technique, which is exclusive to Plessey, has minimised the physical size and weight of the equipment, enhances reliability and provides maximum long-term economy in operation. It has enabled Plessey to develop a full specification transmitter within a volume of approximately 0·168 m^3 (6 ft^3).



Specification

Audio input
Frequency band: 200 Hz to 600 Hz or 200 Hz to 3200 Hz
Impedance level: 600 ohms balanced (nominal)
Audio input level: –20 dBm to +10 dBm

Modulated input
Frequency: 100 kHz
Bandwidth: up to ±6 kHz
Level: 10 m W p.e.p.
Impedance: 75 ohms unbalanced

Output
Power output: 1 kW mean (cw and fsk), 1 kW p.e.p. (isb ssb)
Frequency range: 2 MHz to 29·9999 MHz in 100 Hz increments (280 000 channels)
Channel spacing: 100 Hz
Transmitter bandwidth: up to ±6 kHz within 2 dB

Modulation
A1, A2, A3A, A3B, A3H, A3J, A7A, A7B, A7J, A9B, F1, F4 and F6 can be transmitted when a modulated tone is available. Facilities are available to accept an externally modulated 100 kHz input
Harmonic and spurious radiation: better than –43 dB relative to fundamental
Intermodulation products: better than –40 dB re two equal test tones
Output load impedance: 50 ohms nominal unbalanced
Maximum load VSWR for full output: not exceeding 3:1
Noise and hum: –50 dB relative to p.e.p.
Frequency stability: warm-up from 0°C: 1×10^{-6} per hour after 15 min

Other characteristics
Tuning: automatic, 30 sec maximum
Keying speed on F1: 120 bauds (maximum 400 bauds)
Telegraph input level: 6 V-0-6 V, 80 V-0-80 V single/double current
Environment: the equipment is sealed and generally meets the requirements of DEF 133L3. Operating temperature: 0°C to +55°C
Cooling: LDE internal built-in forced-air heat exchanger and fan
Interface level between drive unit and input to the amplifier: 100 mW p.e.p.
Power supply: 220 V to 250 V ±6% single-phase ac, 50 to 60 Hz ±5%
Power consumption: 3·6 kVA at 0·85 power factor for full output, single tone
Extended control: up to 200 m (656 ft) with 12-wire cable
Remote control: all functions displayed and controlled over a telephone channel or radio link

Dimensions
Linear amplifiers: 432 × 738 × 470 mm (17 × 33 × 18½ in)
Drive unit: 420 × 152 × 508 mm (16½ × 6 × 20 in)
Remote control encoders: 432 × 89 × 305 mm (17 × 3½ × 12 in)
Monitor unit: 432 × 178 × 178 mm (17 × 7 × 7 in)

Weights
Linear amplifier: 172 kg (380 lb)
Drive unit: 19 kg (45 lb)
Remote control encoder: 7 kg (15 lb)
Monitor unit: 4 kg (10 lb)

THE PLESSEY COMPANY LIMITED
Electronics Group
Vicarage Lane, Ilford, Essex, England
Telephone: 01-478 3040 Telex: 23166

1969

Radio-telephone

for vehicles

Pye Westminster universal radio-telephone

This modern frequency-modulated or amplitude-modulated equipment is weatherproof and extremely rugged. It can be operated in either the single- or two-frequency simplex mode on up to ten adjacent 25 kHz or 50 kHz channels in the frequency range from 25 MHz to 174 MHz. The RF output is 12 to 15 W. It is suitable for use in all types of military vehicles including lorries, cars, Land Rovers, gun-carriers and motorcycles. It can be mounted internally or externally.

PYE TELECOMMUNICATIONS LIMITED
Newmarket Road, Cambridge, CB5 8PD, England
Telephone: Cambridge 61222 Telex: 81166

1966

Section 25

Other communications and electronic equipment

General-purpose handset

Field telephone

Nylon handset

Envoy headset

Flexible support

Hand-held waterproof microphone

Hand microphone and headset assembly

Boom microphone and receiver assembly

Noise-excluding headset

Audio ancillaries

handsets, headsets and microphones

S G Brown Ltd has, from the inception of the company in 1910, worked closely with the British defence forces in supplying telephone headsets and acoustic devices. The first item we ever supplied was the famous 'Type A' headset; so successful was this headset that it remained in service for a period covering thirty years, which speaks well for our design and manufacturing capability.

Throughout the period 1910 to the present S G Brown has worked closely with the defence forces throughout the world and kept abreast of all developments involving acoustic devices.

The items illustrated in this Catalogue are only representative of our complete range of equipment, details of which will be supplied gladly on request.

General-purpose handset
Designed for use by operators wearing steel helmet (Mk 4), under conditions outlined in Joint Services Specification K1147. Insets EM1 and EM2 microphone or receiver. Carbon microphone No 1.

Field telephone handset
For use over any two-wire system. Distance telephone-to-telephone in excess of 19 km (12 miles). Completely self-contained. Built-in line amplifier, call tone generator and battery.

Nylon handset
Very tough, lightweight and ideally suitable for use with all types of mobile equipment. Design permits easy replacement of the lead and component parts at field servicing level. Insets as general-purpose handset above.

Hand microphone and headset assembly
One of a series of tank commander's head and breast sets manufactured by Browns. Available with many variations in electrical design and junction box facilities.

Boom microphone and receiver assembly
Can be worn beneath most types of steel helmet. Unit remains fully operational despite extreme conditions of temperature, driving rain, salty spray and dust. Many optional alternatives, such as earpads, insets, cables, junction boxes, etc.

Noise-excluding headset
Fully weatherproofed. Liquid-filled circumaural seals and foam polyurethane earpads combine to give excellent rejection of high ambient noise. Microphone noise-cancelling. Built-in transistor amplifier and battery version available.

Hand-held waterproof microphone
Lightweight. High-impact nylon housing. Shockproof and watertight insets available: noise-cancelling, moving-coil, electromagnetic and carbon.

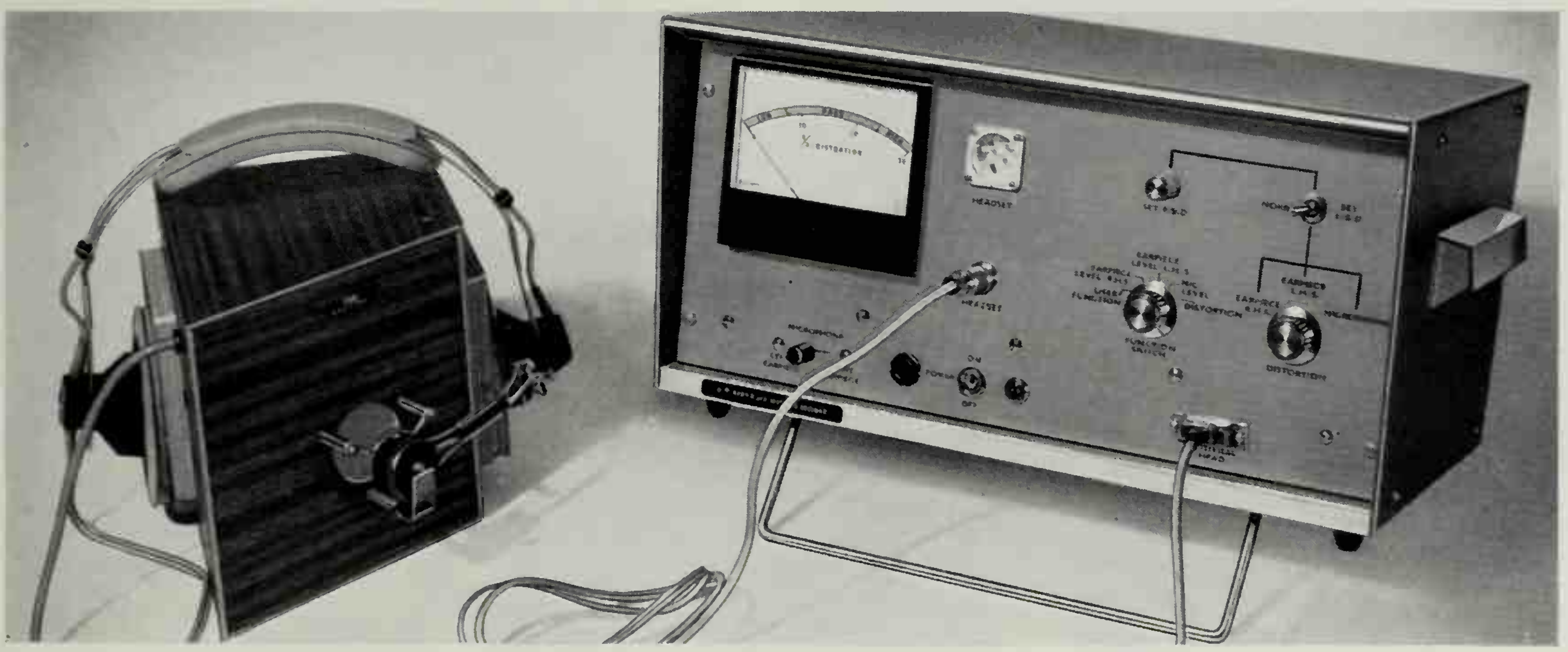
Flexible support
A series of shockproof, flexible microphone housings. The head is designed to accept various types of insets, including noise-cancelling. Press-to-talk facility also available.

Envoy headset
Highest quality acoustic performance and utmost comfort. Insets, receivers: moving-coil; microphone: moving-coil noise-cancelling. Applications include air traffic control and language laboratory use.

Headset tester
This tester, shown below, is simple to read, with go-no-go test facilities for the following functions: continuity, response levels and distortion. Control unit approximately 410 × 210 × 262 mm ($16\frac{1}{8} \times 8\frac{1}{4} \times 10\frac{5}{16}$ in). Artificial head approximately 230 × 180 × 150 mm (9 × 7 × 6 in). The tester offers first and second-line test facilities for use by headset users and/or service engineers.

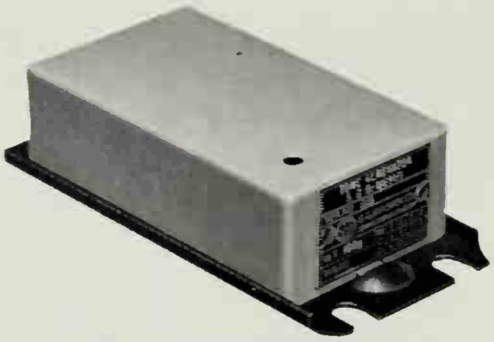
First-line testing facilities:
1) Receiver operation: Left and right-hand receivers check independently with aural tones
2) Microphone operation using the spoken word with visual indication that correct output levels are obtained.

Second-line testing facilities using the artificial head and a go-no-go visual indication of acceptability are as follows:
1) Sensitivity of microphone and receivers at 1 kHz
2) Distortion measurements on microphone and receivers at 1 kHz with visual indication of percentage distortion.

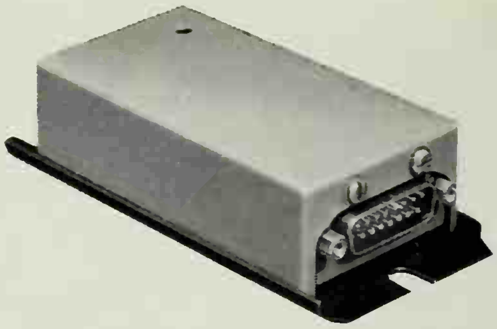


A Hawker Siddeley Company

S G BROWN LIMITED
Communication Division
King George's Avenue, Watford, Hertfordshire, England
Telephone: Watford 23301 Cables: Radiolink Watford Telex: 23412



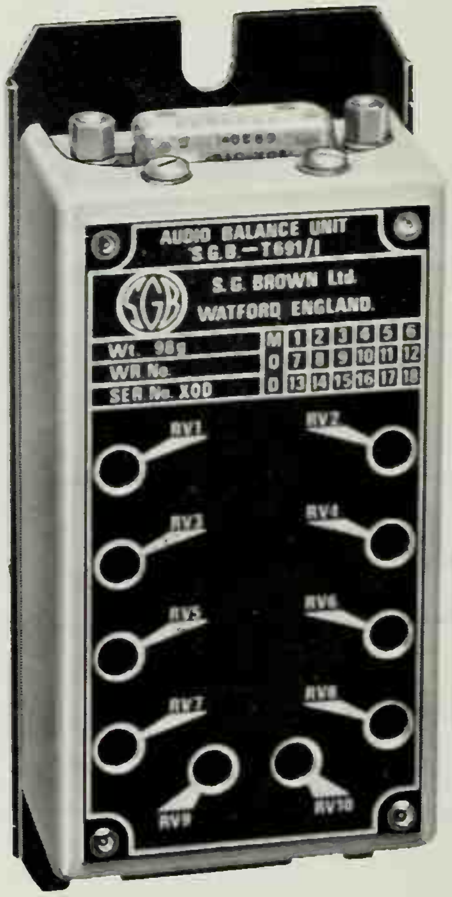
Tone generator W691



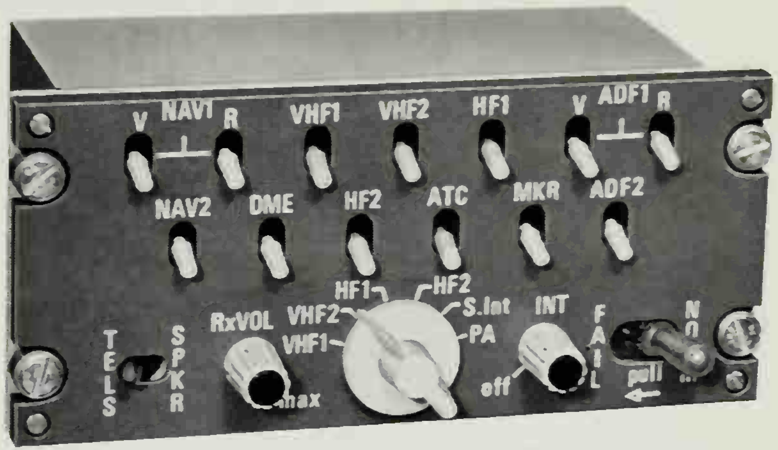
Amplifier Type A692

VOL
off
AMSPEAKER S.G.B.—L693/1
S.G.BROWN Ltd
WATFORD ENGLAND

Amspeaker Type L693


AUDIO BALANCE UNIT
S.G.B.—T691/1
S.G. BROWN Ltd.
WATFORD ENGLAND.
Wt. 90g
WR No.
SER No. XOD
RV1
RV2
RV3
RV4
RV5
RV6
RV7
RV8
RV9
RV10

Audio balance unit T691


V NAV1 R
VHF1
VHF2
HF1
V ADF1 R
NAV2
DME
HF2
ATC
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ADF2
TELS
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S.Int
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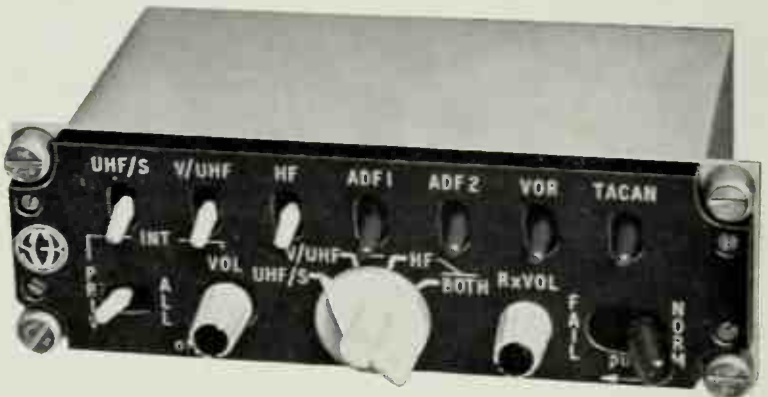
NORM

Station box B692


UHF/S
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ADF 2
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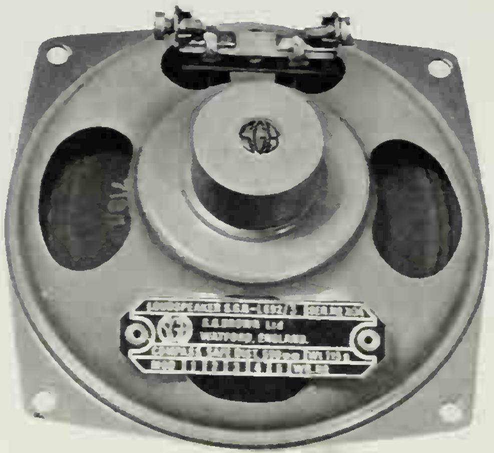
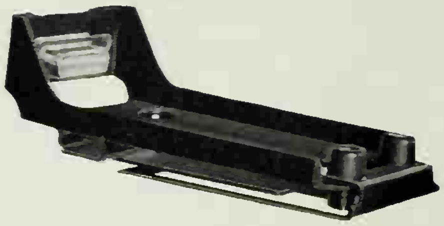
NORM

Station box B691



Loudspeaker L692

Loudspeaker L691



Mounting tray M691

Intercom equipment

for military and civil aircraft

S G Brown's avionic audio integrating and intercom equipment is designed as an extremely lightweight series of units which can be built into almost any form of aircraft audio system to meet the needs of all types of military and civil aircraft, from light spotter aeroplanes to the larger rotary and fixed-wing types. Special-to-type systems are built if required; the company also manufactures special-to-type controllers. The following describes the principal units in the standard system.

Audio balance unit T691

This unit enables the aircraft audio signals from any installation to be precisely balanced in level before being fed into any audio integrating system. Housed in the standard case 86 × 48 × 27 mm the unit weighs 98 grammes and is easily stowed by way of the three 6·0 mm fixing slots.

Station box B691

A highly versatile station box designed to meet the wide range of intercom and audio selection requirements met in helicopter, executive, military and other aircraft audio integration applications. The station box provides for incompatibilities between various microphone and transmitter types by means of its integral silicon-integrated adaptation circuits. Its size is only 47 mm high by 65 mm deep on standard RTCA/ARINC Dzus fixings. The weight is 512 grammes. The front panel colour, engraving and lighting are to user's choice.

Station box B692

A station box with an increased number of facilities compared with the smaller B691 unit. The extra facilities enable it to meet the audio control requirements of large aircraft in both civil and military roles. The internal integrated circuitry provides, in addition to telephone outputs from the isolation amplifier, all necessary matching between differing microphone and transmitter types. Airborne voice recorder outputs are also provided.

Front panel colour, engraving, and lighting are to user's choice. Weight 620 grammes, dimensions—67 × 65 mm on standard RTCA/ARINC Dzus.

Passenger address amplifier A695

This is an extremely small 15 W amplifier with priority inputs suitable for any aircraft up to feeder-liner size. Larger installations may be built up by operating units in parallel or in stereo. Its size is 86 × 48 × 27 mm and it weighs 160 grammes.

Amplifier Type A692

This amplifier has been designed to meet the aircraft requirements for intercom, audio isolation, microphone amplification, telephone and general audio applications in conjunction with carbon (or simulated carbon) microphone headsets and systems.

The amplifier employs integrated circuitry and is contained in a standard small case approximately 86 × 48 × 27 mm and it weighs 160 grammes. The unit is provided with three 6·0 mm fixing slots permitting a choice of fixings which facilitates easy stowage in the aircraft.

Amplifier Type A691

This amplifier has been designed to meet the aircraft requirements for intercom, audio isolation, microphone amplification, telephone and general audio applications in conjunction with electro-magnetic microphone headsets and systems.

The amplifier employs silicon-integrated circuitry and is contained in a standard case 86 × 48 × 27 mm and weighs 140 grammes. The unit is provided with three 6·0 mm fixing slots permitting a choice of fixings which facilitates easy stowage in the aircraft.

Mounting tray M691

This is a miniature mounting tray for use with any unit using the S G Brown standard avionics miniature package box. It is particularly suited for use where a quick-release fixing is required. Its size is 110 × 35 × 55 mm and its weight is 64 grammes.

Amspeaker Type L693

This unit comprises a small 105 mm diameter loudspeaker contained in a small case together with an integral power amplifier. The amplifier provides loudspeaker drive, priority and muting circuits. The unit is ideally suited for installations in cockpits and small aircraft cabins. Silicon-integrated circuits enable the unit size to be kept to 140 × 114 × 52 mm and weight to 420 grammes. A volume control is accessible on the front of the unit. Alternatively, an on/off switch or pre-set level control can be fitted.

Power amplifier A693

This amplifier provides a 5 W audio output capable of driving aircraft cockpit and/or cabin loudspeaker installations of varying impedances. The unit is small and easily stowed. Three 6·0 mm fixing slots are provided for mounting, its size is 86 × 48 × 27 mm and it weighs 140 grammes. Priority or mute switching is provided with the various inputs.

Loudspeakers L691 and L692

Two loudspeakers with the size and capability to satisfy most aircraft loudspeaker installation requirements.

Both units are moving-coil direct-radiation, cone loudspeakers in chassis form.

The larger L691 unit employs an inverted magnet type of construction, enabling the overall depth to be kept to 40 mm; its diameter is 168 mm and its weight is 515 grammes.

The L692 is of conventional construction but measuring only 105 mm diameter by 42 mm deep. Its weight is 115 grammes.

Screw terminals are provided on both units for ease of installation.

Tone generator W691

Tone generator Type W691 has been designed to meet the requirement for air-crew station: warning, cautionary and advisory signals in fixed and rotary-wing aircraft, and as such conforms to ASCC/AIR STD10/30C (1.3.65).

The unit has been designed to operate directly into the user's headset, thus avoiding the use of non-essential electronics such as station box audio mixing/isolation circuits although, if desired, the warning-tone audio can be routed as an audio service.

The unit source impedance has been so chosen that when connected into the headset circuit the normal received audio signals are not degraded. Packaged in a small case 86 × 48 × 27 mm the unit may be mounted anywhere in the aircraft where conditions permit. Its weight is 108 grammes.

When activated by a sensing switch the unit gives audio warning of dangerous temperature rise, pressure change, attitude, auto-pilot failure or any other desired condition.

A Hawker Siddeley Company

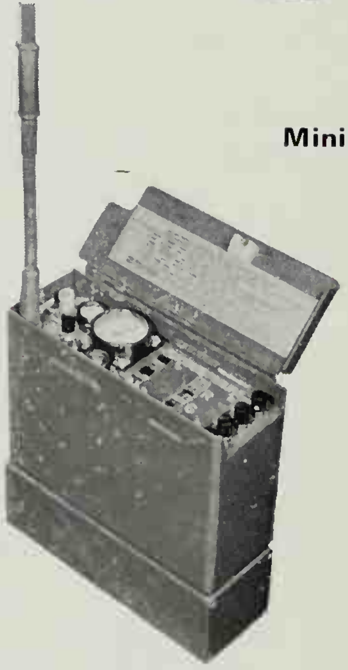
S G BROWN LIMITED
Communications Division
King George's Avenue, Watford, Hertfordshire, England
Telephone: Watford 23301 Cables: Radiolink Watford Telex: 23412

Mk 21 multipulse receiver

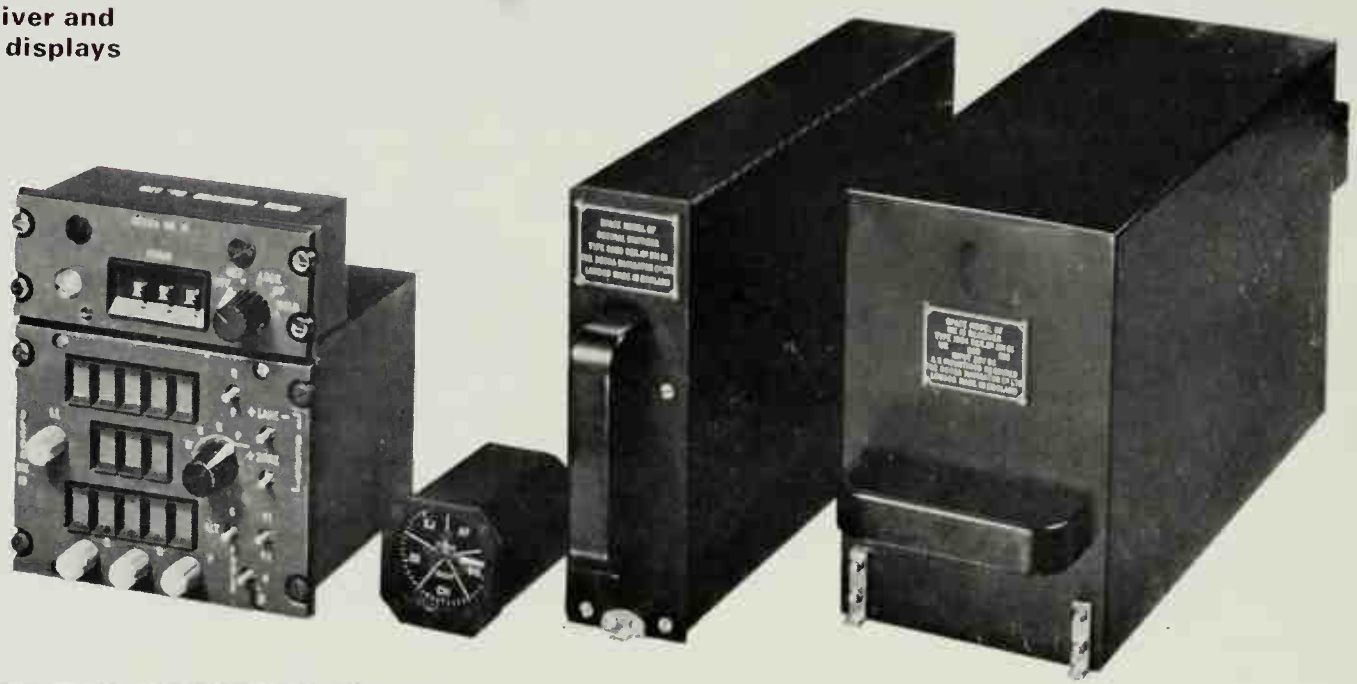
Marine automatic plotter Type 350

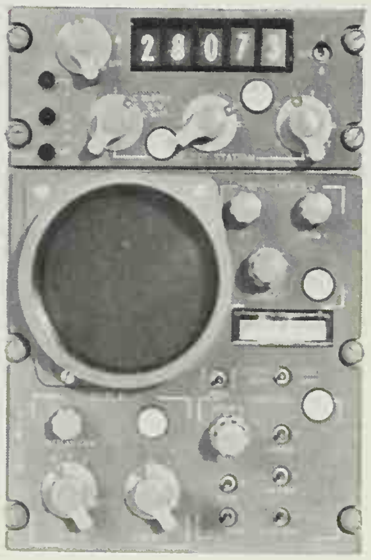
Hi-Fix
survey receiver

Minidec receiver



Mk 19 receiver and
associated displays





Loran C/A ADL 21 readout unit
Type 1833 and CRT unit Type
1832

Loran C/A ADL 21 receiver
unit Type 1831

Navigation system

Decca Navigator equipment for all services

The Decca Navigator, a highly accurate radio position fixing system, serves as a common navigation aid for ships, aircraft and land vehicles. Established for nearly 25 years, it operates at all altitudes down to ground level and at distances up to several hundred miles. It is now recognised as the standard for marine navigation and its potential for aviation is universally accepted. Over 14 500 vessels and 3500 aircraft, including helicopters, are fitted with Decca equipment.

The system's mode of operation is by a chain of ground-based transmitters emitting continuous low-frequency signals which follow the earth's contours, creating a fixed hyperbolic pattern. Each hyperbola represents positions of zero phase difference between a slave and master transmitter, so that all users share a common reference. This is of particular importance in such operations as search and rescue, naval manoeuvres, and minesweeping. The hyperbolic grid can be overprinted on standard charts. In aircraft, because of the higher speeds involved, information is presented on a moving-chart pictorial display providing a continuous record of position and track.

A short-range derivative, Hi-Fix, uses mobile transmitters and has a base-line accuracy of one metre, making it ideal for hydrographic survey work. Maximum operating range of Hi-Fix over sea is up to 320 km (200 miles). For marine and airborne duties not requiring the operating range of Hi-Fix a compact solid-state version, Sea-Fix, is available, with an operating range of 32 km (20 miles) over sea water.

Mk 21 multipulse receiver
This self-contained solid-state unit operates in conjunction with the Decca Navigator system to provide highly accurate radio position fixing of vessels of all types and classes. It provides for all 63 Decca main chain frequencies plus an additional setting for special applications. It employs the multipulse technique for accurate lane identification even at ranges beyond the present Ministry of Transport approved limit of 445 km (240 nm). The equipment includes replaceable plug-in circuit boards, combined Decometer and Lane Identification display and an in-line digital readout giving the lane value to the nearest tenth. A range of built-in power units permits operation from 12, 24, 32, 110 and 220 V dc and from 80–260 V ac at 40–400 Hz. Power consumption is minimal.

Marine automatic plotter Type 350
Operating in conjunction with a Decca Navigator Mk 21 marine receiver, the Type 350 track plotter produces a continuous pictorial record of a ship's position. Positional information from the receiver is fed into a servo amplifier which controls the pen on chart movement.

The equipment has particular application to navigation in fishing operations, hydrographic surveying, minesweeping and rescue work.

Hi-Fix survey system
Installations in hovercraft, survey vessels and dredgers have proved the Hi-Fix mobile survey system unrivalled in both accuracy and flexibility. Based on the Decca Navigator principle, Hi-Fix provides position references accurate to within 1 metre on the master/slave baseline and outputs for both track plotter and autopilot facilities.

Omnitrac
A general purpose navigational computer capable of accepting information from Hyperbolic, VOR/DME, Doppler, inertial and air data DR sources and processing it to provide automatic navigation, pictorial display, autopilot coupling and many other facilities including flight profile.

Aircraft position and track are displayed on the automatic Mk 6A display head.

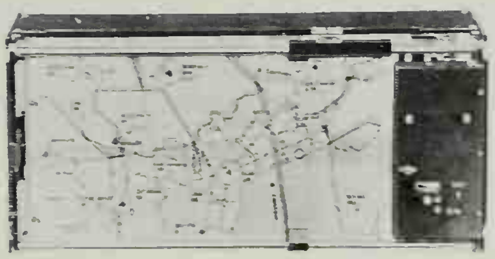
Minidec receiver
Designed for use by infantry, Minidec brings ground troops into the same navigational grid as their supporting aircraft. This self-contained robust receiver operates up to 480 km (300 miles) from the master station.

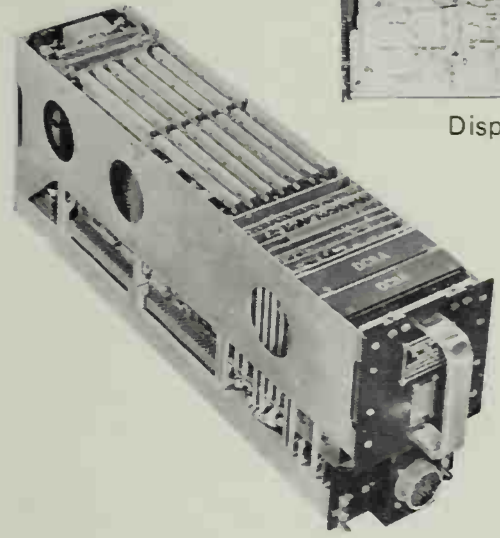
Mk 19 military Decca navigator receiver
A solid-state airborne unit which can operate from any Decca chain either existing or planned. Operating in two modes, the Mk 19 provides the pilot with a flight log pictorial display, and the navigator with a meter display. Other operational features include zone identification, automatic lane setting, and a 'run/fix' facility which simplifies and relaxes the process of changing charts.

Loran C/A ADL 21
A low-cost highly accurate long-range navigation system; its airborne receiver can track automatically and continuously very weak signals. Typical fix accuracies are 180 m (200 yd) for Loran C and 915 m (1000 yd) for Loran A. Ranges over sea-water are for Loran C ground-waves 2220 km (1200 nm) and sky-waves 3700–5500 km (2000–3000 nm), and for Loran A ground-waves 1300 km (700 nm) and sky-waves 2800 km (1500 nm).

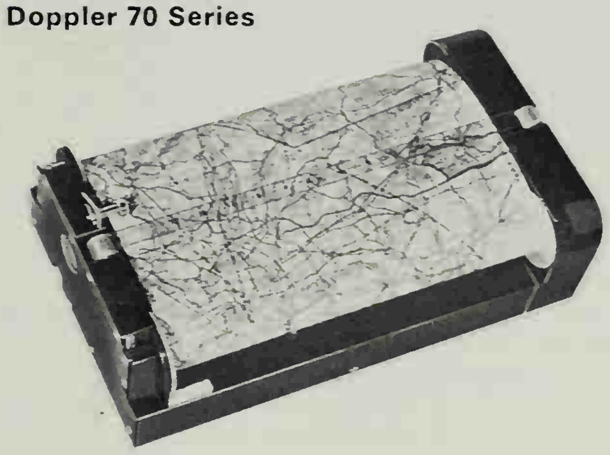
Doppler 70 series
A lightweight navigation radar of solid-state construction which provides outputs of velocity, along and across heading, to a navigational computer. The V/STOL version, Type 71, also provides vertical velocity.

Omnitrac

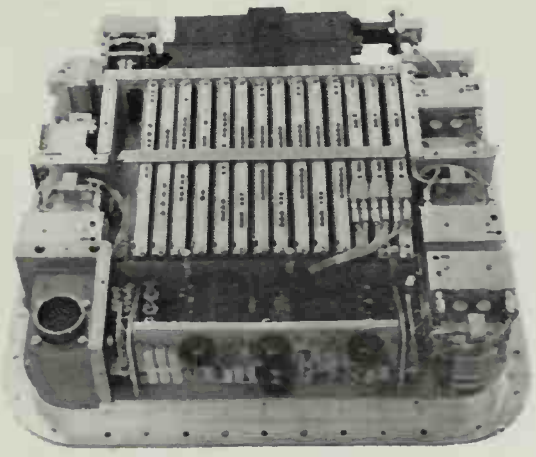

Display head Mk 6A


Omnitrac Mk 2B digital computer

Doppler 70 Series

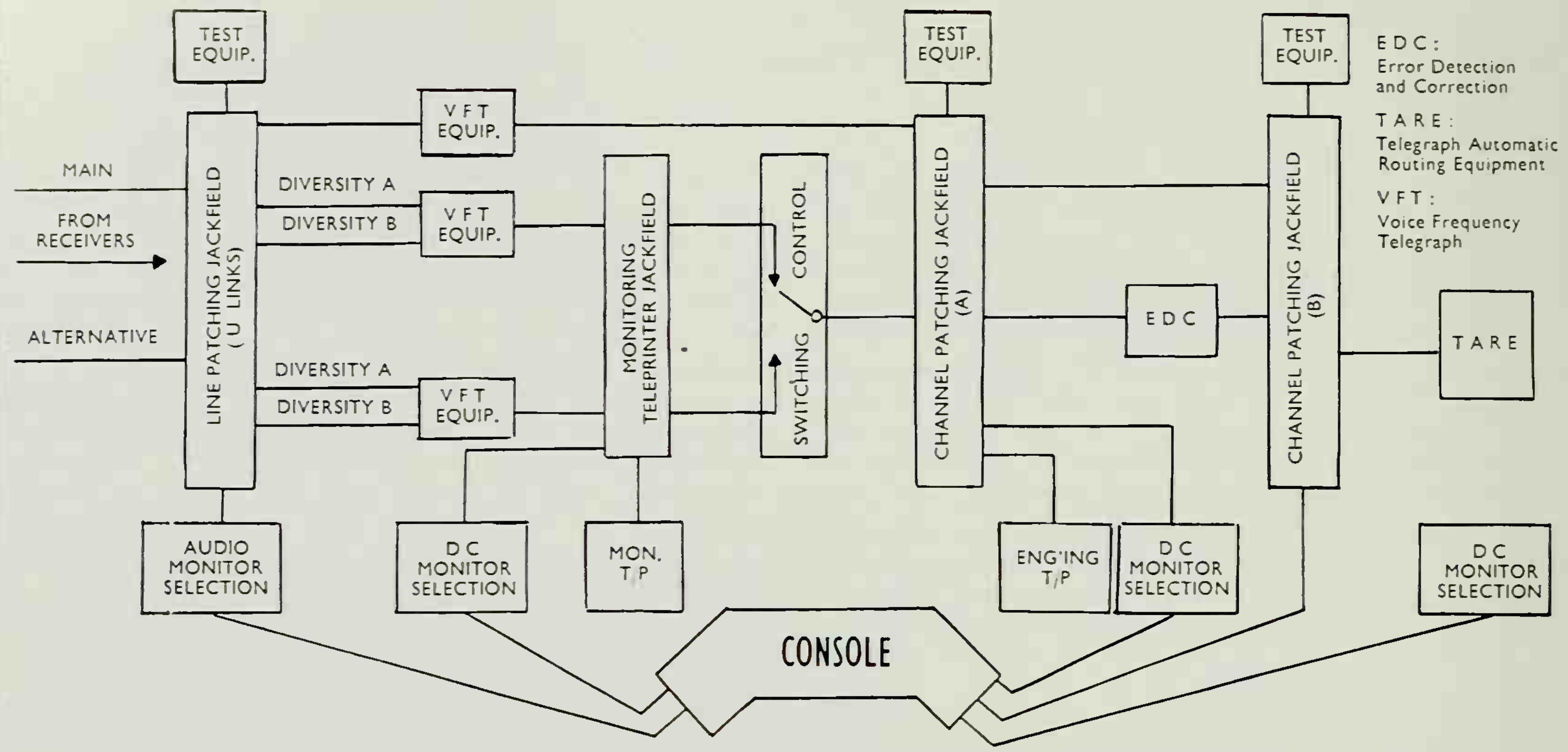

Roller map Mk 5

Ground speed and drift meter


Electronics of antenna

Hover meter

THE DECCA NAVIGATOR COMPANY LTD
Decca House, 9 Albert Embankment, London SE1, England
Telephone: 01-735 8111 Cables: Decnav London SE1 Telex: 28588


TEST EQUIP.
TEST EQUIP.
TEST EQUIP.
E D C: Error Detection and Correction
T A R E: Telegraph Automatic Routing Equipment
V F T: Voice Frequency Telegraph
MAIN
FROM RECEIVERS
ALTERNATIVE
LINE PATCHING JACKFIELD (U LINKS)
DIVERSITY A
DIVERSITY B
DIVERSITY A
DIVERSITY B
V F T EQUIP.
V F T EQUIP.
V F T EQUIP.
MONITORING TELEPRINTER JACKFIELD
SWITCHING CONTROL
CHANNEL PATCHING JACKFIELD (A)
E D C
CHANNEL PATCHING JACKFIELD (B)
T A R E
AUDIO MONITOR SELECTION
D C MONITOR SELECTION
MON. T/P
ENG'ING T/P
D C MONITOR SELECTION
D C MONITOR SELECTION
CONSOLE

TYPICAL COMMUNICATIONS CONTROL CENTRE EQUIPMENT—RECEIVE PATH SCHEMATIC

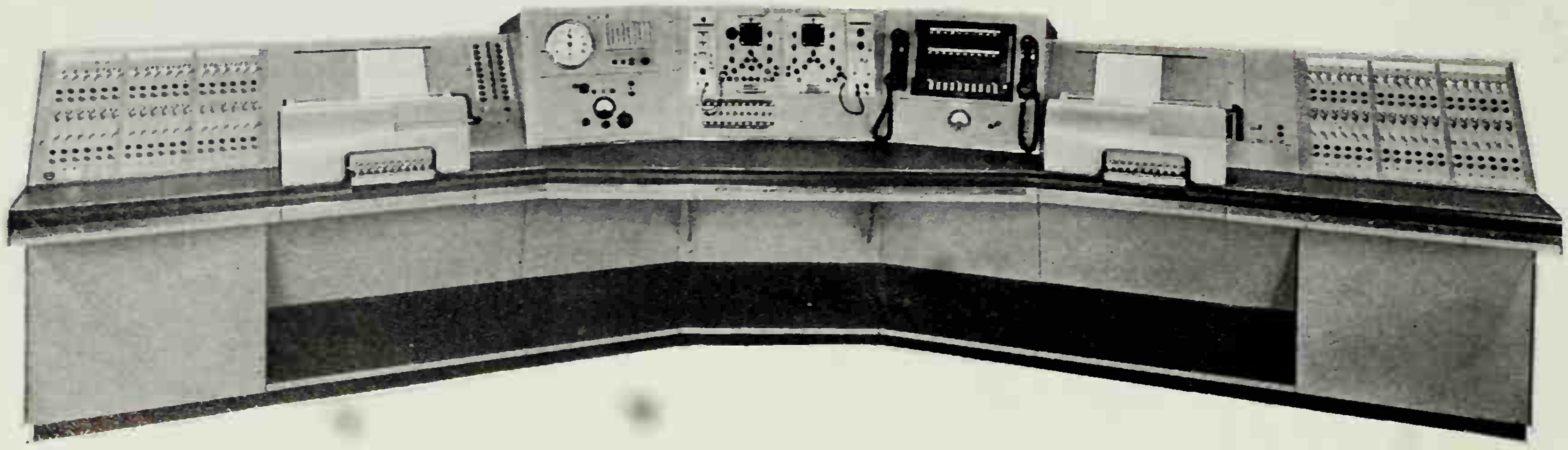
This photograph shows a typical layout for the system control console. The console and its associated apparatus racks enable the selection of any audio or dc circuit at line or internal levels. The dc circuits may be selected automatically by keyswitches on the console. The line chosen may then be connected, dependent on the type of information it carries, to one or more of the following test instruments: telegraph distortion measuring set, telegraph distortion unit, tone monitoring amplifier, dc voltmeter.

The telegraph distortion measuring set and the telegraph distortion unit are used together to analyse dc telegraph signals. The distortion level is measured with the TDMS, while the TDU assists in locating the cause of distortion. The voltmeter is used to check line voltages on dc telegraph circuits.

The tone monitoring amplifier enables audio circuits to be monitored and is connected manually at the line or internal jackfields.

Supply and fuse facilities in the equipment are monitored by a relay set, and lamp indication is given on the left-hand side of the central part of the console. An alarm bell is fitted inside the console to enable aural indication to be given of any failure.

In this particular system monitoring teleprinters and channel switching units have been incorporated at either end of the main console.



Control systems

for large communications centres

Force commanders with adequately planned and equipped radio communications systems can only issue information and orders with the certainty that forces will react to them if the communications links are effective. Even with the most modern radio systems, man has not completely overcome the effects of variations in the ionosphere, nor can any defence communications system operate on the assumption that no link in the network can fail.

National defence arms now adopt the concept of a communications control system to detect and diagnose any abnormality in the communications system and to provide the means to restore full facilities, usually by re-routing or bringing reserve equipment into service.

International Aeradio Limited, using operational and technical expertise gained in providing communications requirements for the world's airlines over nearly a quarter of a century, has been concerned with the design, development and production of such communications control systems for the British Navy, Army and Royal Air Force over the last decade.

Specification

General

Each communications station utilises radio transmitters and receivers which themselves act as bearers for modulated signals. These comprise a number of voice channels and a larger number of telegraph channels, all of which may be processed by cryptographic means prior to transmission and after reception to minimise their use by an intercepting agency. The control system comprises units which enable the technical operators to locate abnormalities and to take remedial action.

All incoming paths from the receiver station to the control centre and all outgoing paths to the transmitter station from the control centre, as well as the alternative routes between the centre, the receiver and transmitter sites, are routed via U-link panels in line-patching jackfields.

All lines from telegraphy machinery, or associated cryptographic machinery, and all lines to terminal equipment are routed via jack panels in channel-patching jackfields.

Between the control centre and the local transmitter and receiver sites, an internal liaison system of telegraphic communication is provided. Between the control centre and the distant transmitter and receiver sites, an external liaison system of telegraphic communication is provided using the engineering channels on the radio system.

The heart of the control centre is the technical monitoring unit, used to assess the quality of any line passing through the system. The selected line can be routed by uniselectors and relays to test equipment mounted in the unit for aural and qualitative setting. The unit can also contain circuit alarms and an alarm panel providing visual indication of fuse or power supply failure.

All monitoring, testing and ancillary equipment is housed in one control console, which forms the nerve centre of the system.

Line-patching jackfield

Each standard U-link panel consists of two rows of 32 U-links, and from six to 11 panels can be housed in a standard 1·83 m (6 ft) fully enclosed steel cabinet. Space at the top of each cabinet is provided for test equipment, typically a line level measuring set and an audio oscillator for line characteristic measurement and fault location.

Channel-patching jackfield

The standard jack panels for 80-0-80 V dc working consist of two rows of 20 jacks; for low-level 6-0-6 V dc working, one row of 20 jacks.

Space at the top of each cabinet is provided for test equipment. Space lower down can be utilised by a cord shelf fitted with 12 double-ended fully retractable cords. Loose patch cords can be provided if preferred.

Under normal operating conditions the face of the jackfield is clear of jack cords and only under fault conditions would patch cords be used for patching out faulty terminal equipment or outgoing lines.

Monitoring teleprinter jackfield

Jack panels and cabinets are similar to those of the channel-patching jackfield. All send and receive lines within the system are routed via this jackfield so that any number of telegraph channels can be monitored. Additionally, two full duplex teleprinters are connected for the engineering of single channel FSK (frequency shift key) circuits.

Control console

The following units form the main control console:

Internal liaison system: This is a local system and has only a three-position switch at the control centre to make calls to, or receive calls from, the transmitter and receiver sites.

External liaison system: This is intended for communication with any of the distant stations and has therefore a more sophisticated calling system. Calling of a distant station is initiated by key-switch operation.

Test and monitoring system: An extremely comprehensive test and monitoring system has been designed. It consists of three-bay housings with selection keys, monitoring equipment for dc and audio lines, and an internal telephone system. The three-bay housings, known as the technical monitoring unit, are used to assess the quality of any line passing through the system. A comprehensive system of check-back lamps is used to indicate that the selection equipment has operated correctly.

The technical monitoring unit also contains an alarm panel which, by means of lamps, provides circuit alarms and indicates fuse or power supply failure. The telephone switchboard is used for communication with external and internal subscribers using the system.

Channel switching controls: These form part of the main control equipment and are situated on the outer ends of the control console. Each unit contains 18 channel switching strips and is capable of controlling three SSB circuits. Each channel switching strip contains keys, lamps, and relays for the control of:

(a) Reception of a particular channel of either red or yellow system
(b) In the case of non-reception on both red and yellow, the routing of a holding mark battery to the terminal equipment
(c) Transmission of mark, test calls, or traffic on the red or yellow systems simultaneously or independently
(d) Calling of the traffic hall operator to indicate circuit availability

The strip indicates:

(a) Distortion on the receive side when exceeding a pre-determined amount
(b) Reception of a corrupt message by the traffic hall operator
(c) Distortion on the send side when exceeding a pre-determined amount
(d) State of security of both the send and receive sides.

The top half of each strip is associated with the receive side of a channel and the lower half with the send side.

INTERNATIONAL AERADIO LIMITED
Aeradio House, Hayes Road, Southall, Middlesex, England
Telephone: 01-574 2411 Cables: Intaerio Southall Telex: 24114

IAL

Above: At their Data Centre at Woolwich, England, the Royal Electrical and Mechanical Engineers use an ICL 1904 computer for the recording and analysis of repair, modification and performance of all types of military equipment all over the world.

Higher productivity from technical manpower, better management of military equipment, more accurate forecasting of spare parts requirements, and design improvements including greater reliability and ease of maintenance are the four main objectives; all can lead to useful savings in costs.

These machines are also used for specific research and development work, and can exchange data with other ICL computers working within the British Ministry of Defence.

Below: Over 250 000 items are held in this store at No. 16 Maintenance Unit, RAF Stafford, England. Records and accounts are held on an ICL 1903 machine, one of the four used by RAF equipment supply depots.

Each of these computers makes use of a number of remote teletypewriters, enabling the system to take account of events as they occur. For example, a keyboard operator notifies the computer of incoming goods from the point of receipt—within seconds information is printed out on the same teletyprinter giving the exact location for storage.

All users of ICL 1900 computers have a ready-made program package, SCAN, available without extra charge. This analyses demand patterns, forecasts demand on the basis of these analyses, and computes re-order points, allowing supply sources to reduce stock holding to a minimum level and to reduce the number of stock-out situations.

BS
BT
BV
BU
AT
50

Electronic computers

for all defence purposes

International Computers Limited is the largest European organisation in the commercial and scientific computer fields, with an annual turnover exceeding £115 million. ICL conducts marketing operations in 70 countries and exports one-third of its output. It offers multi-purpose computers, ranging in value from approximately £35 000 to several million Sterling, which welcome comparison with any in the world.

In addition to the 1900 Series computers described below, ICL also manufactures the powerful System 4 range of computers, which have a powerful real-time capability.

ICL makes not only the hardware (computers and computer equipment) but also the software, or programs, many of which are provided as a free service. Two of the most widely used items are FIND, an information retrieval system, and SCAN, a stock control system.

Multi-purpose computers

The contribution of multi-purpose computers, such as those manufactured by ICL, depends on their power, their peripheral equipment, and the nature of the programs written for them.

ICL currently offers a wide range of peripheral equipment to enable users to exploit the computing capability of ICL computers to the fullest extent.

Computers in defence

ICL has provided most of the computers used for administrative and scientific training purposes by the British armed forces, who have used them for many years and are turning to them more and more.

The armed services have for many years been among the most enterprising and efficient computer users in the United Kingdom in exploiting the advantages of computers over conventional systems. In the last decade the use of computers throughout the defence function has grown enormously and the range of applications has been considerably increased.

Some defence functions could not be carried out at all without computers. Early warning systems, for example, could not exist without them. Similarly detailed simulation exercises, such as war games, and large-scale projects, such as equipment reliability studies or information retrieval systems, all require computers to store and collate large quantities of information compactly and reliably. Other functions, such as standard costing, stock control, and manpower planning, can be performed without computers but the computer can pay immense dividends in improved efficiency and reduced costs.

A brochure is available on the use of ICL computers in four broadly defined areas of the defence function: weapons and equipment, personnel training and deployment, logistic support, and the use of management information for tactical, strategic and policy decisions.

The 1900 Series

Main characteristics

This is a versatile range of computer systems, from the small to the very large. Some 2000 have been delivered or are on order.

An important feature of the series is hardware and software compatibility which allows processors and peripherals to be changed unit by unit to develop the total system without wasting the user's original investment in equipment or programs.

Hardware compatibility is achieved through a 'standard interface' and software compatibility through a standard instruction set and an operating system design philosophy which allows programs written for one system to be run on another of sufficient capacity. This feature provides a back-up facility of great importance in defence.

Because the central processor in a modern system works much faster than the peripheral units, the 1900 Series adopts the principles of simultaneity (whereby the processor can continue work while peripherals carry out their task) and multi-programming (whereby most processors in the range can work on a number of programs at the same time). ICL computers have proven remote communications ability; equipment is available to give full data transmission facilities.

All 1900 computers made today use integrated circuits which give increased reliability and processing power.

Performance

Core store capacities range from 4096 to 4 194 304 words, each word holding 25 binary digits.

Speeds range from the 1901A which adds two seven-digit numbers in 28·5 microseconds and multiplies in 100 microseconds, to the 1906A which adds in 0·9 microseconds and multiplies in 1·5 microseconds.

Salient features of design

In addition to compatibility, simultaneity and multi-programming mentioned above, the 1900 Series uses a word format of 25 binary digits. This helps to reconcile maximum simplicity of circuitry, speed of processing, and utilisation of store.

Comparison

The 1900 Series is broadly comparable in performance and price with anything available elsewhere. There is a full range of peripheral equipment, including visual display units, graph plotters, document readers and mass file storage. Programs may be written in COBOL, FORTRAN, or ALGOL, or a special 1900 language. An extensive range of program packages is available.

Design/development/production state

The 1900 Series has been proved in five years' operating experience all over the world.

Delivery

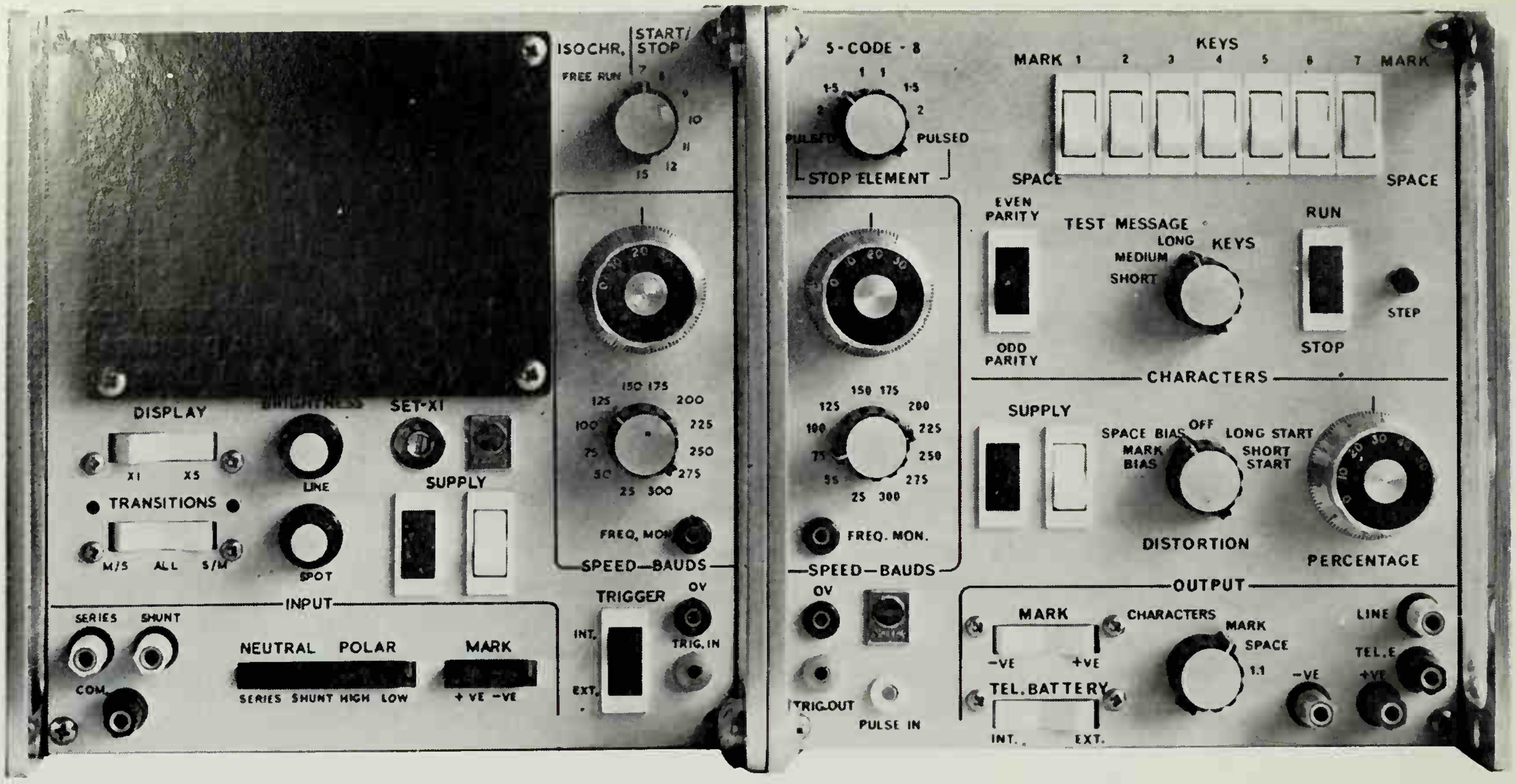
Delivery is from just under a year to a year and a half depending on the size of the system.

Order of cost

From £30 000 to over £1½m depending on the size of the system.

INTERNATIONAL COMPUTERS LIMITED
Defence Area
Victoria House, Southampton Row, London WC1, England
Telephone: 01–405 7866

ICL


ISOCHR.
START/STOP
FREE RUN
DISPLAY
X1
X5
BRIGHTNESS
SET-X1
LINE
SUPPLY
TRANSITIONS
M/S
ALL
S/M
SPOT
SPEED—BAUDS
FREQ. MON.
TRIGGER
INT.
EXT.
0V
TRIG. IN
INPUT
SERIES
SHUNT
COM.
NEUTRAL
POLAR
MARK
SERIES SHUNT HIGH LOW
+VE −VE
5-CODE-8
PULSED
STOP ELEMENT
KEYS
MARK
SPACE
EVEN PARITY
ODD PARITY
TEST MESSAGE
LONG
MEDIUM
SHORT
RUN
STOP
STEP
CHARACTERS
SUPPLY
SPACE BIAS
MARK BIAS
OFF
LONG START
SHORT START
DISTORTION
PERCENTAGE
OUTPUT
TRIG.OUT
PULSE IN
TEL. BATTERY
INT.
EXT.
LINE
TEL.E
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+VE
1:1

TDMS.80 telegraph distortion measuring set

This unit, companion to the telegraph signal generator type TSG.40, is a compact, lightweight portable equipment for measuring telegraph distortion on signals using 7 to 13 element codes over the range from 25 to 330 bauds.

Incoming signal transitions produce bright-ups on a raster displayed on a 10 × 6 cm cathode ray tube. The raster produces a line or trace for each element of the unit code selected, thus enabling the individual character elements to be measured on the scale calibrated for early and late distortion over the range 0 to 50 percent. A X5 switch permits the range to be set to 0 to 10 percent. A continuous or free-run single trace is also provided to facilitate speed measurement and the assessment of isochronous distortion.

The input circuit is fully isolated from chassis and suitable for the shunt measurement of polar and neutral signals over the range 3 to 200 V. Facilities are also provided for use on neutral series circuits over the current range 10 to 100 mA.

The design is based on integrated circuits and utilises discrete components as appropriate.

The TDMS.80 is available in a portable case or, in association with the TSG.40, can be rack-mounted in 482 mm (19 in) international standard racking.

TSG.40 telegraph signal generator

This unit, companion unit to the telegraph distortion measuring set TDMS.80, is a compact, lightweight, portable equipment providing a wide range of accurately generated test signals to International Alphabets No 2 and No 5 for the testing of telegraph and data systems, machines and associated equipment.

TSG.40 functions over the range 25 to 330 bauds. Facilities are provided for introducting start element or bias distortion by means of a continuously variable control calibrated 0 to 50 percent distortion. Three electronically generated test messages together with a single repeated character set by front panel controls are provided for both the five- and eight-level codes.

A serial output signal is provided by an electronic relay suitable for both polar and neutral operation. A parallel output signal is available from a socket at the rear of the equipment, at logic level.

An internal signalling supply can be provided.

Equipment design is based on integrated circuits and utilises discrete components as appropriate.

The TSG.40 is available in a portable case, or, in association with the TDMS.80, can be rack-mounted in 482 mm (19 in) international standard racking.

Specification

Operational data

Input: electronic, isolated from chassis
Shunt monitoring (polar or neutral): 100 kilohm impedance, 3–200 V range
Series monitoring (neutral): 10–100 mA
Display: 10 × 6 cm CRT with raster
Display range: 50% or 10% full scale, calibrated in 1% or 0·2%
Display accuracy: 1%
Operation: start-stop or isochronous
Signalling speed range: 25–330 bauds continuously variable
Signalling speed accuracy: ±1% overall, resolution 0·03 baud
Unit code, range: 7–13 units in one-unit increments

Physical data

Power supply: 92–132 V or 185–265 V, 50–60 Hz, 45 VA
Environment, operation: 0° to +55°C, storage –10° to +70°C
Dimensions: 216 × 221 × 406 mm (8·5 × 8·7 × 16 in)
Weight: 9·5 kg (21 lb)

Specification

Operational parameters and physical data to match those of TDSM.80, except weight: 8·8 kg (19·5 lb)
Code: CCITT No 2 and No 5; 1 unit start element; 1, 1½ and 2 unit stop element
Output signals: steady mark; steady space; reversals (1:1);
  CCITT No 2: 96-character Fox test; 32-character RY test; 8-character Q95
  CCITT No 5: 96-character Fox test; 32-character U test; 8-character Q95
  Repeat characters set by keys
Internal signalling supply: ±6 V, ±30 V, ±80 V
Operation: continuous or pulse release (6–200 V)

Telegraphy equipment

Operational aids

TAA.70 tape reading and automatic addressing equipment

This is a desk-mounting unit for reading punched paper tape and automatically generating a series of characters to precede and to follow tape transmission. It comprises two electro-mechanical tape readers and an electronic telegraph character generator operating to 5-unit CCITT No 2 alphabet, over the range 45 to 130 bauds in either free-run or pulse-release mode.

When a punched paper tape is loaded into either reader a serial telegraph signal will be transmitted to line, comprising a start signal, a number of preset characters, circuit or channel identity and transmission serial number (SOM) the characters on the tape and an optional further set of end-of-message characters.

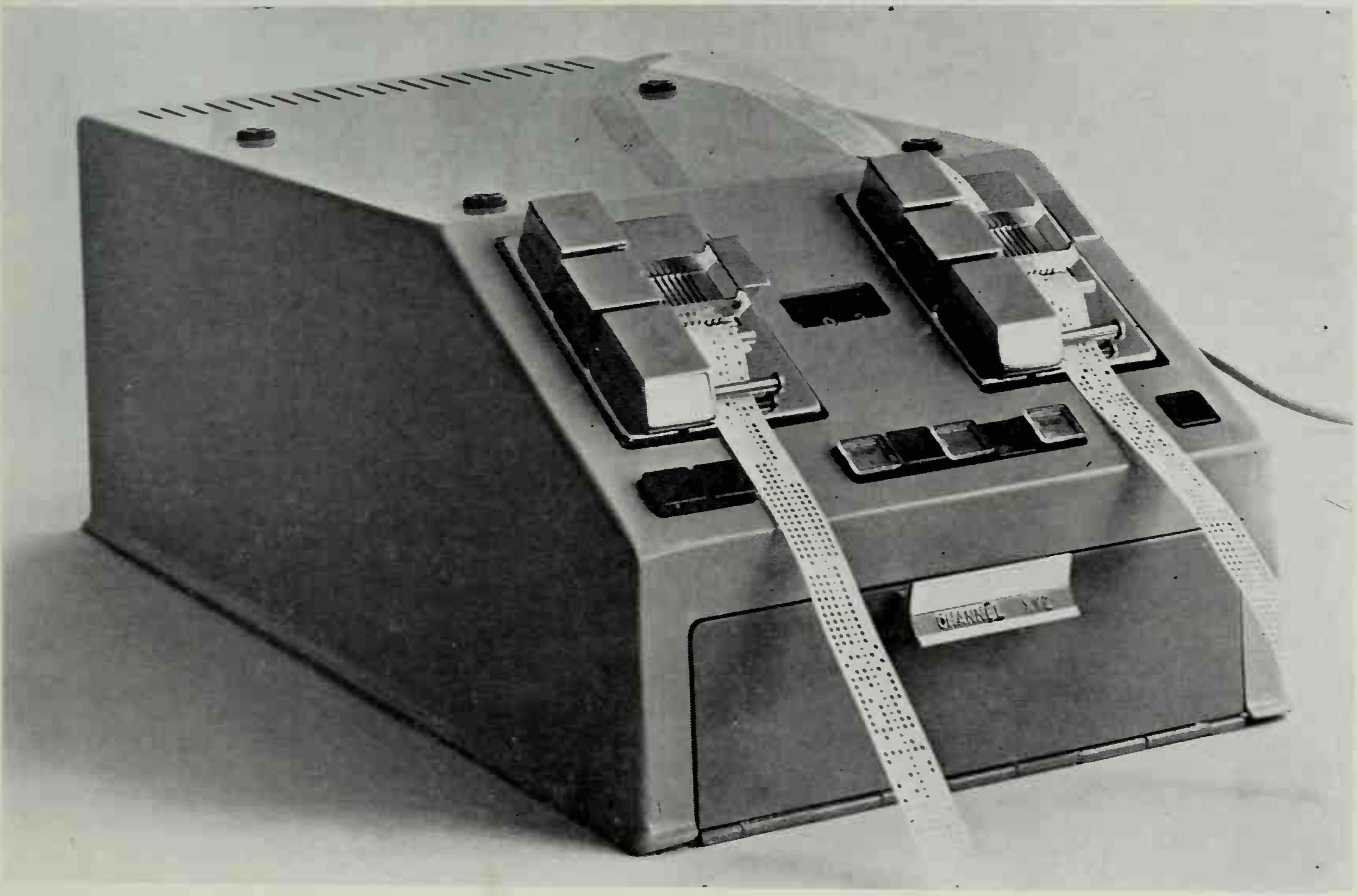
The two readers operate independently or alternately so that, if tape is loaded into the second reader, transmission from it will follow automatically, being preceded by the start signal and SOM format.

An electronically generated cancel-transmission text is provided under operator control.

A break-transmission pushbutton stops the transmission at the end of the character being sent. When released, transmission restarts at the next character.

Facilities are provided for generating a test message for circuit testing.

The equipment allows considerable flexibility in the make-up of the automatically generated sequences. It also includes facilities for remote control of certain functions. The design is based on solid-state integrated circuits and discrete components. The tape readers and the serial number coders are electro-mechanical.



Specification

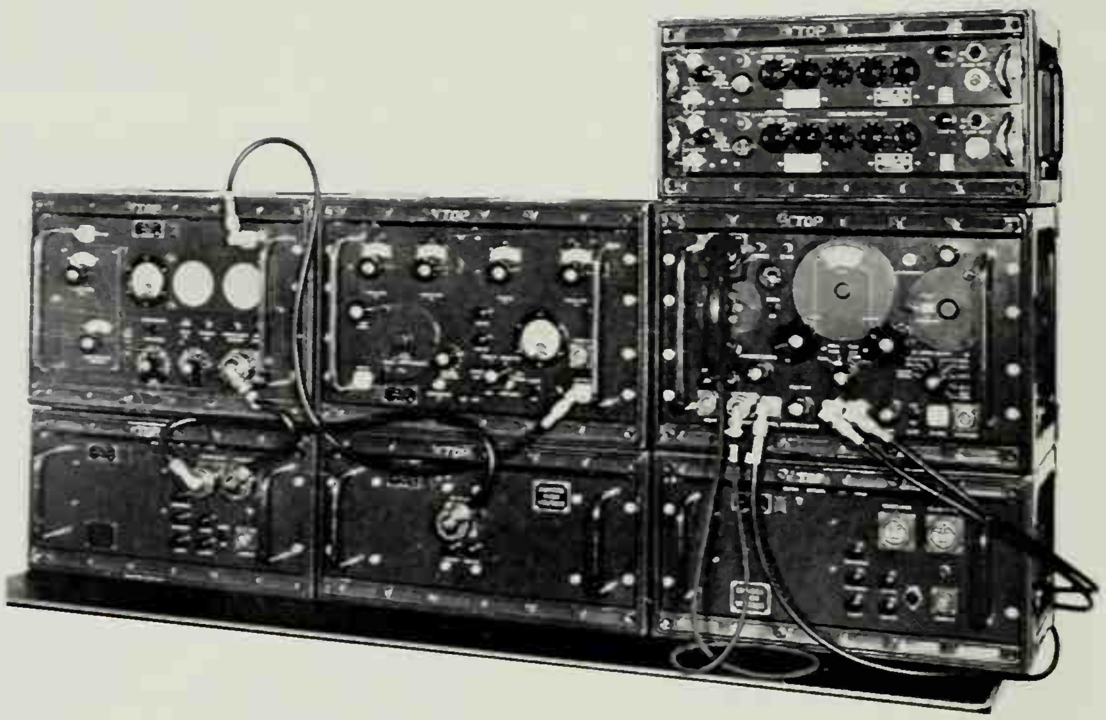
Operating data
Speed: three spot speeds 50, 75, 100 bauds
Range: 45–130 bauds
Fine speed control: ±5%
Code: CCITT No 2; 1-unit start; 1, 1½, 2-unit stop
Output signal: isolated electronic relay, ±6 V to CCITT V 24
Operation: continuous or pulse-release (6–200 V)

Physical data
Power supply: 92–132 and/or 185–265 V
Environment: operation 0° to +55°C, storage –10° to +70°C
Dimensions: 241 × 178 × 482 mm (9·5 × 7 × 19 in)
Weight: 104 kg (231 lb)

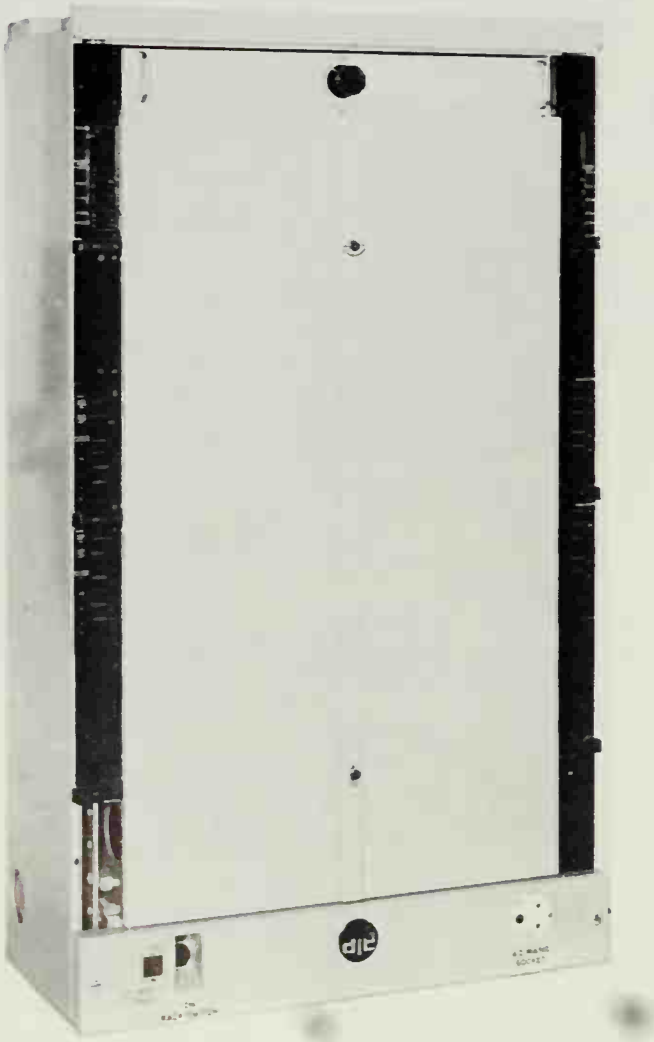
THE PLESSEY COMPANY LIMITED
Automation and Transmission Divisions
Sopers Lane, Poole, Dorset, England
Telephone: Poole 5161 Telex: 41272

1969

Left: The Type 1100 radio relay equipment is a solid-state modular construction unit designed with due consideration of CCIR and other specifications, and is suitable for handling traffic on 12, 24 or 36 telephone channels



Above: The self-contained units of this Plessey C50 mobile UHF radio relay equipment can be arranged in any preferred configuration to suit the available space



Left: The A7E secrecy equipment is a compact self-contained unit for ensuring full security of telephone conversations. Over one hundred scrambling patterns can be set by means of code cards

Speech and data links

for radio and telephone networks

Type 1100 radio relay equipment

This equipment has been designed to operate in the frequency band from 404 to 470 MHz (which can be extended to 1427–1535 MHz by using additional units) with 12, 24 or 36 telephone channels frequency division multiplexed into a traffic baseband from 6 kHz to 180 kHz. The engineer's order wire occupies the baseband below 6 kHz. Angle modulation (F3) is used and receiver and transmitter frequencies are preset to customer requirements. An antenna filter is included which can be connected as a diplexer or as a separate filter.

The Type 1100 has a wide range of military applications including short-haul toll and spur routes, emergency services, remote control and telemetry links, pipeline systems, power transmission systems and railway systems, data transmission and VF telegraphy.

The equipment can be used as a repeater station, in which case it is of the fully demodulating type. An outstanding feature of the equipment is the built-in metering facility which provides monitoring of all important circuit conditions.

Space diversity and frequency diversity versions of the system can be provided.

Specification

Frequency range: 404–470 MHz (1427–1535 MHz using alternative units)
Traffic baseband: 6–180 kHz
Engineer order wire and supervisory baseband: 300 Hz–6 kHz
Input level from multiplex equipment: –45 dBm nominal at 75 ohm unbalanced
Output level to multiplex equipment: –15 dBm nominal at 75 ohm unbalanced
Transmitter output power: >3 W at 450 MHz, 1 W at 1500 MHz
Deviation per channel: ± 35 kHz
Frequency stability: Better than 0·003% over whole temperature range
Antenna impedance: 50 ohm nominal unbalanced
Ambient temperature range: –25°C to +60°C
Relative humidity: Up to 95% from 0°C to +30°C
Power requirement: 24 V (21·5–28 V) positive earth at 2 A
Dimensions: 483 × 533 × 254 mm (19 × 21 × 10 in), free-standing or 483 mm (19 in) rack mounting
Weight: Approx 27 kg (60 lb)

C50 mobile UHF radio relay equipment

This equipment has been designed for the British Army to provide reliable radio communication links to carry multi-channel voice and teleprinter circuits. It is now in service, following rigorous field trials over the most rugged terrain. The C50, when used with the PG 342 digital frequency synthesiser, operates on any radio channel in the band from 225 to 400 MHz and provides baseband capability for up to 24 channels using FDM ancillary equipment. In certain circumstances 24-channel equipment can be provided for fixed stations, and 6- or 12-channel equipment is available for mobile stations. Alternatively, the system may be used with a 6-channel PCM equipment. The transmitter radiates either a minimum of 10 W in the standard form or more than 200 W in the high-power version, thus permitting communications over both line-of-sight and near line-of-sight paths as required.

Principal characteristics include full duplex operation using easily erected cross-polarised log-periodic antenna systems; simplified controls and procedures permitting station set-up in less than 15 minutes; quick channel selection through either a six-crystal turret or a digital frequency synthesiser, an engineering channel; unit construction for simplified maintenance and servicing; robust design for mounting in either 483 mm (19 in) racks or transportable cases; satisfactory communication over circuits of 65–80 km (40–50 mile) paths with a typical loss of 160 dB, or over shorter paths when advantage is taken of natural camouflage or where there is obstruction. The equipment conforms to the appropriate section of the British Defence Specification DEF 133.

Variations to cabin layout may be made, as no rigid adherence is necessary to any particular arrangement.

Type A7E secrecy equipment

The Type A7E secrecy equipment has been developed for use where security of telephone conversations is essential. It is based on the five-band 'scrambler' device employed for many years on long-distance radio links. The use of transistors and other modern components now enables such units to be manufactured in a compact form.

The equipment is designed to operate with normal telephone instruments and uses a speech band from 250 to 3000 Hz. This band is divided into five sub-bands of 550 Hz each, which are modulated, filtered and reassembled in some other sequence for transmission to the distant equipment. This 'scrambled' speech band is not intelligible to anyone intercepting it en route, even if the necessary technical equipment is available, unless the combination of inversions and translations being employed at the time is known. Over a hundred such combinations are possible and the change from one to another can be made at any time by substitution of the code card at each station.

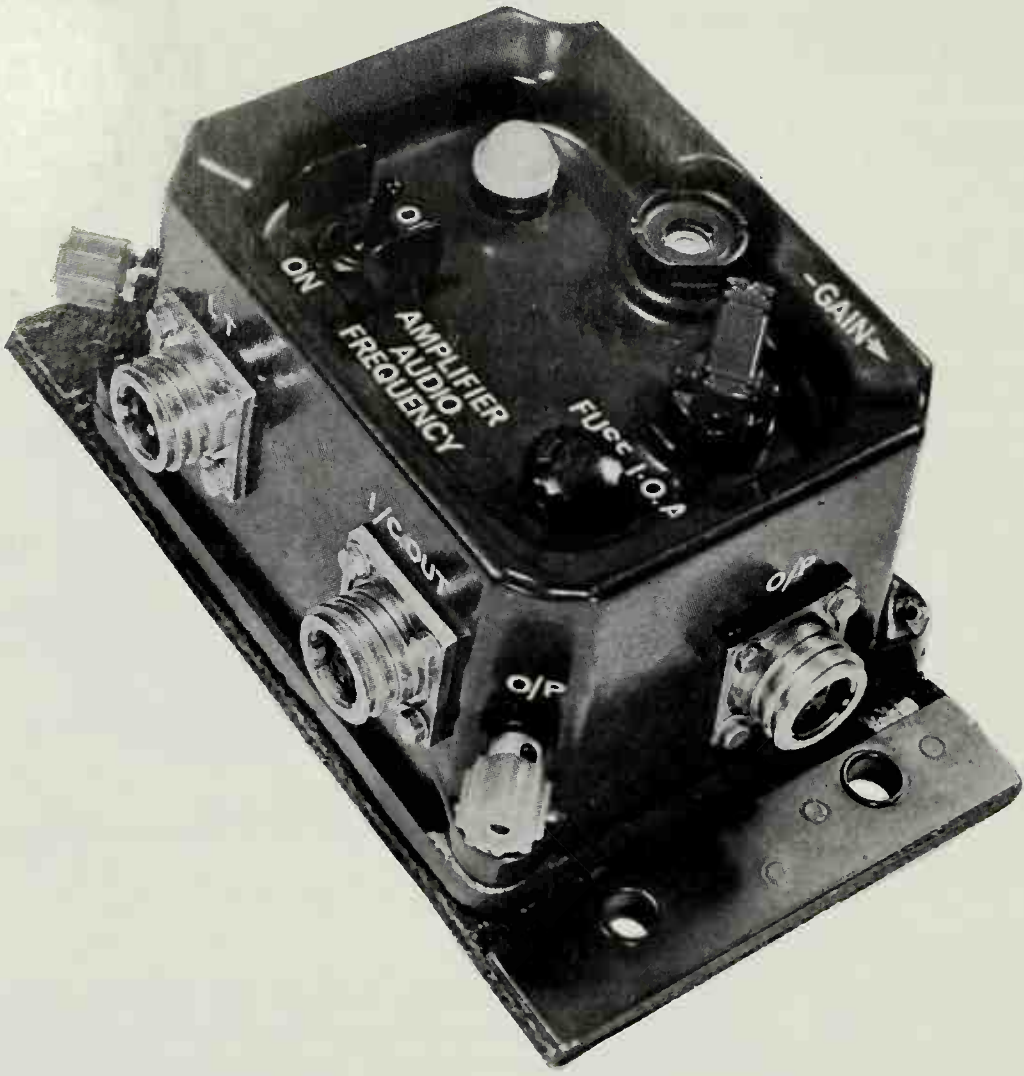
The equipment consists of two main sections, the translating equipment which converts each sub-band to and from its allotted position in the frequency spectrum, and the frequency generating chain which produces the various frequencies used in the modulation processes.

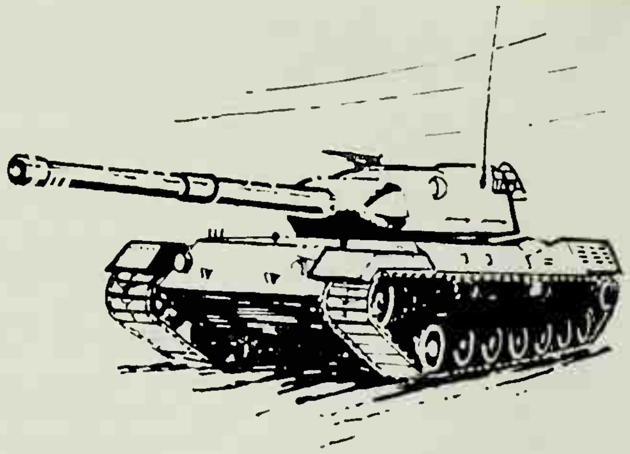
A simple switch enables the secrecy equipment to be brought into service or taken out of service by agreement at any time. This switch is located adjacent to the user's telephone instrument.

The equipment is fully transistorised, operates from ac mains and is mounted in a small sheet-metal cabinet.

THE PLESSEY COMPANY LIMITED
Electronics Group
Vicarage Lane, Ilford, Essex, England
Telephone: 01-478 3040 Telex: 23166

1969





The 5W audio amplifier (left) is a hermetically sealed bulkhead-mounting inductive loop transmitter designed primarily for installation within fighting vehicles and capable of satisfactory operation to DEF 133/L3. It accepts signal inputs from a microphone/preamplifier or direct from the vehicle's intercommunication wiring harness. With a suitable loop of cable, it provides sufficient output for a reception area of up to 8400m^2 (10 000yd^2) with reception outside the loop limited to only a few tens of metres. All amplifier controls, components and connectors are mounted on the case, with interconnection by flexible cableforms for ease of servicing.

The induction receiver No. 1 (right) is a rugged, reliable lightweight equipment designed to fit into the pocket or a specially designed pouch for personal reception of signals transmitted by the standard range of Spembly inductive loop transmitting equipment. The receiver comprises a pickup coil, fully encapsulated transistor amplifier and long-life battery (150h), housed in a durable ABS polymer case. Audible signals are obtained from an ear-defending, noise-attenuating headset which is connected to the receiver by a standard telephone-type plug, insertion or removal of which automatically switches the equipment on or off. No other controls are fitted. Receiver bandwidth is restricted to minimise interference from 50 and 400Hz sources.

5895 - 99 - 102 - 4947

Communication system

near-field audio type

Spembly Electronics' near-field audio communication system is a one-way inductive communication system which can be established without the use of wires or radio frequencies.

General features

The equipment consists of a 5W audio transmitter amplifier and induction receiver No. 1 described in the captions opposite and in the specifications below, together with appropriate loop cable, microphone (for transmitter), batteries and headsets (for receivers). It is lightweight and portable, but fully ruggedised for global use, and is particularly suitable for communication within armoured fighting vehicles to enable the crew to move about freely without the hindrance of cables. Elsewhere the system is quickly installed or removed. The strictly limited communication zone possesses the advantages of security and freedom from interference.

Installation and operation

The transmission system is established by surrounding the required reception area with a loop of cable (single-core), and connecting the cable to the output terminals of the transmitting amplifier. Also connected to this amplifier are the relevant microphone and battery. Signals from the microphone are amplified and matched to the loop, thus causing alternating currents at low voltage to flow through the loop. The entire area within the loop is filled with a low-level alternating magnetic field which follows the signals coming from the microphone in amplitude and frequency.

The receiver employs suitable circuits that detect the variations in magnetic field, amplify the signals and provide sufficient output to drive appropriate headsets.

Good signals are obtained within the looped area irrespective of buildings and structures within it. Signals can be obtained many yards above and below the plane of the loop, thus loop installation is not critical. The signals will penetrate soil and rocks and can be picked up at the bottom of rivers and other fresh-water areas if so required. However, the strength of the magnetic field outside the loop diminishes rapidly and signal pick-up becomes impossible within a few tens of feet at most.

Service applications

The equipment is currently in use by the British Army and the Royal Air Force and trials are being carried out by the Royal Navy. The very wide range of possible service applications includes:

Control of aircraft ground servicing crews.

Control of bridging and other localised field activities.

Communication within and around armoured fighting vehicles.

Control of vehicles and personnel during localised exercises and demonstrations.

Training of personnel on ranges, gun positions, parachute units.

Emergency instruction of personnel.

Control of warehouse fork lift truck operators.

Helicopter landing aid.

Technical specifications

5W Transmitter amplifier (NATO 5820–99–104–6489)

Signal input 15–21mV across 300Ω for maximum rated output

Maximum output 5W into 5Ω, 1·25Ω or 0·5Ω (pre-set)

Distortion less than 5% at full output

Frequency response 400–4000Hz (3dB relative to 1kHz)

Power requirements nominal 24V dc (20·7–29·0V) negative to chassis
  Quiescent current approx. 0·09A
  Full load current approx. 0·5A

Operating temperature range –20°C to +65°C

Overall dimensions 223 × 130 × 97mm high (8¾ × 5⅛ × 3⅞in)

Induction receiver No 1 (NATO 5895–99–102–4979)

Overall gain +55dB relative to 1·0mV across 600Ω for a field strength of 0·03At/m

Frequency response 600–3500Hz (3dB relative to 1kHz)

Output 1·5mW into 600Ω

Operating temperature range –25°C to +65°C

Dimensions 77 × 125 × 28mm (3 × 4⅞ × 1¼in)

Weight (including battery) 270g (9½oz)

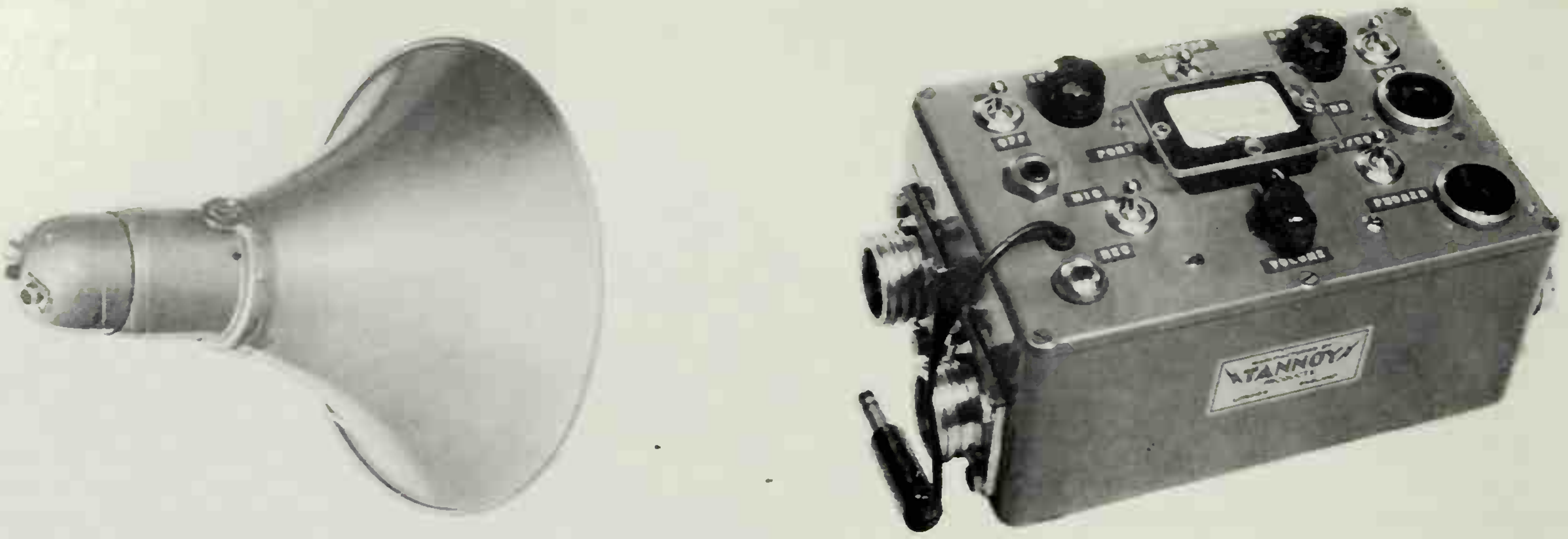
Battery 6·75V Mallory (NATO 6135–99–108–3590)

Accessories: headset, carrying pouch, spare batteries

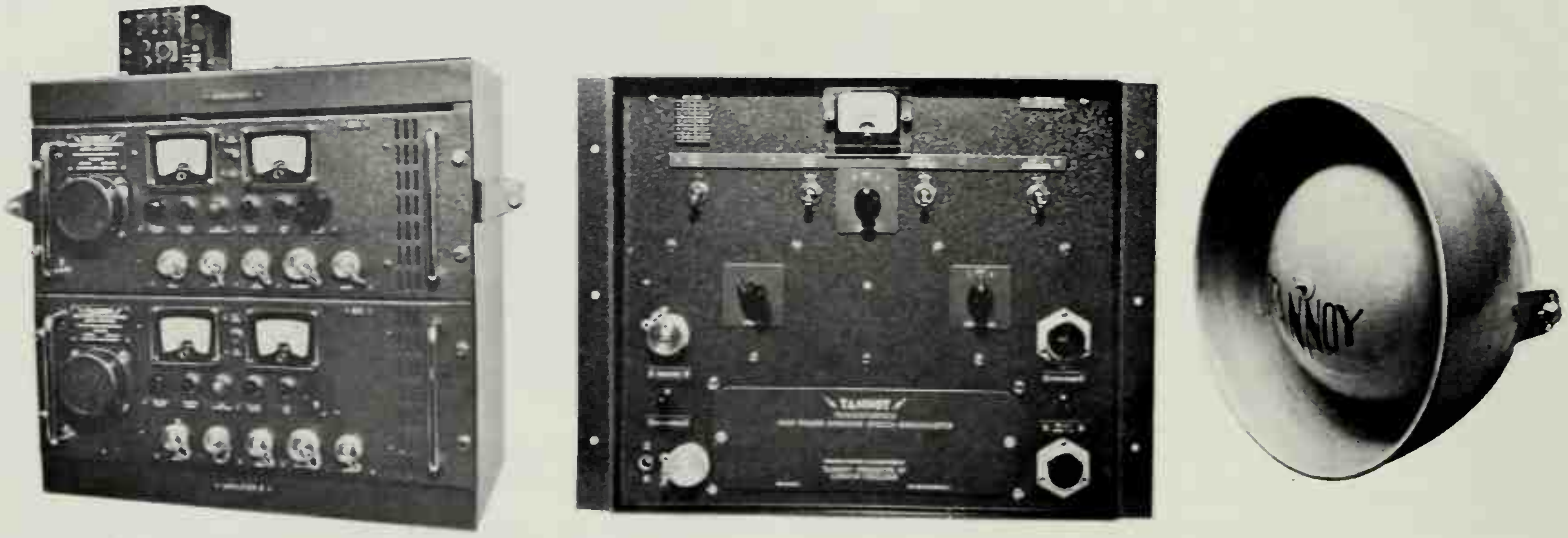
SPEMBLY ELECTRONICS

Enham Arch, Newbury Road, Andover, Hampshire, England

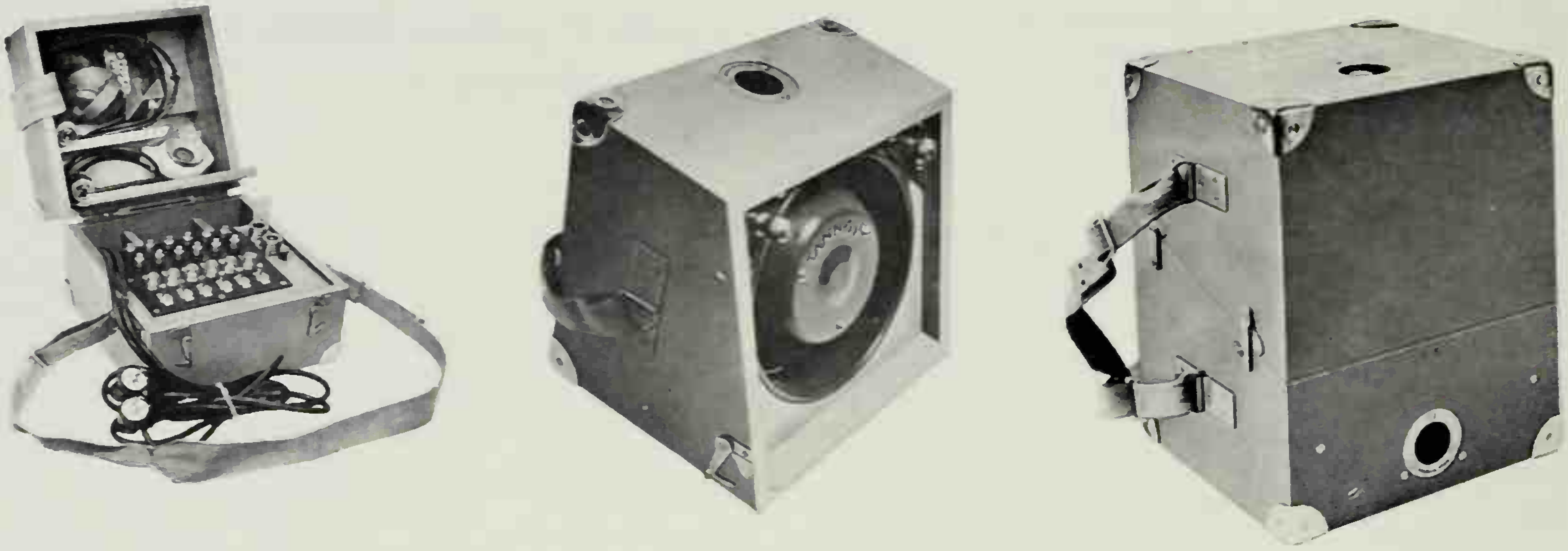
Telephone: Andover 5741



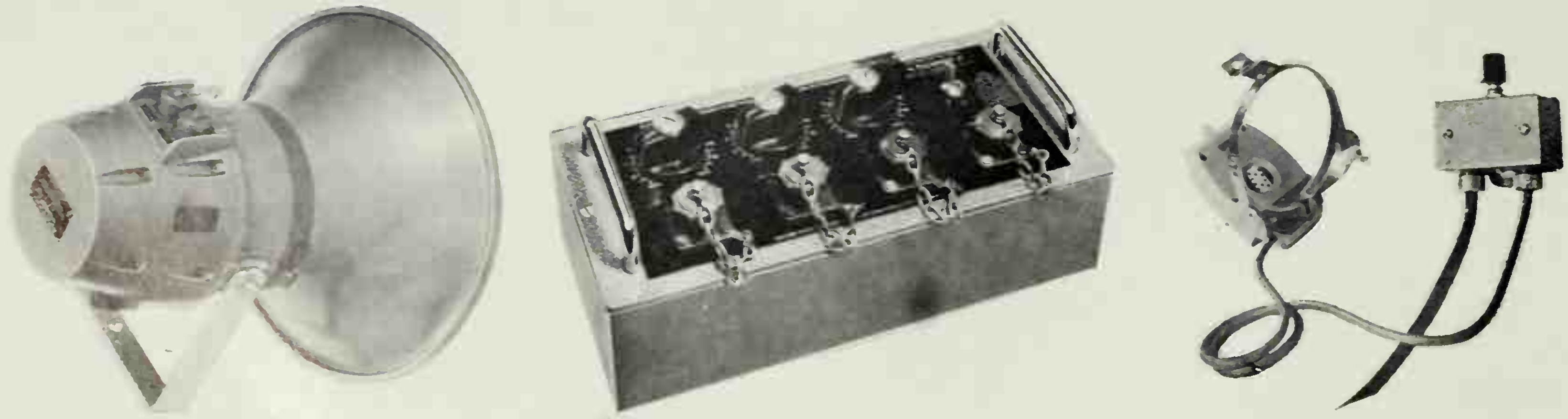
200W sky-shouting equipment: 100W amplifier/loudspeaker (left), control box (right)



800W sky-shouting equipment: twin 200W amplifier assembly (left), control panel (centre), 400W loudspeaker (right)



Gun crew intercom equipment: 6-way control unit (left), single command loudspeaker (centre), two loudspeakers clipped together for transport (right)



General-purpose integrated loudhailer: 25W amplifier/loudspeaker (left), 3-way mixer unit (centre), hand microphone with volume control and gas mask clip (right)

Loud hailing equipment

Tannoy public address and crew control systems

200watt sky-shouting equipment

Loudspeaker/amplifier
Dimensions: 635mm (25in) dia × 840mm (33in) long
Weight: 15·8kg (35lb)
Output: 100W per loudspeaker/amplifier
Power consumption: 7–10A at 24V

Control box
Dimensions: 119 × 94 × 52mm ($4\frac{11}{16} \times 3\frac{11}{16} \times 2\frac{1}{16}$in)
Weight: 2·72kg (6lb)

Designed specifically for fitting to lightweight helicopters and aircraft, the 200W sky-shouting equipment consists of two 100W integrated solid-state amplifier loudspeakers and a small control box which can be fitted adjacent to the operator. The control box incorporates monitoring and power supply test facilities and inputs are available for either tape machines or standard noise cancellation or throat microphones. Although light in weight the equipment is robust and suitable for worldwide service in all climates. A message length of between 30sec and 50sec can be obtained, varying at heights between 300 and 600m (1000 and 2000ft) in good weather conditions. The message length can be increased with helicopters by hovering and with fixed wing aircraft by orbiting.

800watt sky-shouting equipment

Loudspeakers
Dimensions: 635mm (25in) dia × 457mm (18in) deep
Weight: 77kg (170lb)

Amplifiers (twin 200W assembly)
Dimensions: 622 × 610 × 318mm ($24\frac{1}{2} \times 24 \times 12\frac{1}{2}$in)
Weight: 65kg (143lb)
Power consumption: (800W) 45A at 24/28V

Control panel
Dimensions: 407 × 305 × 165mm ($16 \times 12 \times 6\frac{1}{2}$in)
Weight: 7·5kg ($16\frac{1}{2}$lb)

Designed for larger aircraft such as Dakotas, Pembrokes and Andovers, this system comprises four 200W amplifiers accommodated in two cabinets, driving two 400W loudspeakers which normally can be mounted conveniently one under each wing. The equipment has full monitoring facilities and provision for operating from either tape machines or suitable noise cancelling microphones, all incorporated in a control panel which may be built into a console designed for the aircraft selected. When operated at heights between 300 and 600m (1000 and 2000ft) the equipment gives a message length of between 30 and 45sec on a front approximately 400m ($\frac{1}{4}$ mile) wide, assuming a flying speed of approximately 167km/h (90 knots). The equipment is fully approved for worldwide airborne service.

6 and 8 gun crew intercommunication equipment

Loudspeakers (two clipped together)
Dimensions: 305 × 235 × 235mm ($12 \times 9\frac{1}{4} \times 9\frac{1}{4}$in)
Weight 9kg (20lb)

Control unit
Dimensions: 255 × 255 × 210mm ($10 \times 10 \times 8\frac{1}{4}$in)
Weight: 7kg ($15\frac{1}{2}$lb)

This equipment is based upon the original Tannoy Tele LS No. 2 but is now available with six or eight channels and in 12V or 24V versions. It includes both amplified speech reply back and light signalling from individual gun positions, and the command loudspeakers are blast-proof. Both the command and reply back amplifiers are solid-state employing silicon transistors and the complete equipment provides reliable communication, requires the minimum of maintenance and may be installed and operated by personnel with no communications equipment training. Command loudspeakers may be up to 457m (500yd) from the control point using normal 0·7mm (22swg) connecting cable.

General-purpose integrated loud hailer

Loudspeaker/amplifier
Dimensions: 432mm (17in) dia × 420mm ($16\frac{1}{2}$in) long
Weight: 11·3kg (25lb)

This extremely rugged 25W loud hailer may be operated without adjustment from 12 or 24V dc supplies. Its input is derived from either a single microphone or a three-way mixer unit and any number of hailers may be linked together for simultaneous operation providing each one has its own local battery supply. Silicon transistors are used throughout and the loud hailer is fully approved for worldwide service. It has a range in excess of 800m ($\frac{1}{2}$ mile) under still air conditions. It is suitable for vehicle mounting and may be bolted directly to the chassis of either negative or positive earthed vehicles.

TANNOY
Norwood Road, London SE27, England
Telephone: 01-670 1131 Cables: Tannoy London SE27

TANNOY

UHF multicoupler system

for the 225-400 MHz band

The Airtech UHF multicoupler system gives a full capability for high-performance low intermodulation working of several transmitters or receivers into a common antenna. Considerable development has enabled the intermodulation products to be accurately controlled and maintained throughout the life of the system, which in the context of military applications would play a vital role under conditions of emergency operation.

Two versions of the system are available. The simpler system is manually tuned for each channel frequency with the settings indicated on a frequency scale. The more sophisticated version is fully autotune; it has a memory store and is capable of being programmed anywhere within the 225–400 MHz band.

Specially designed filters are incorporated in the equipment. The filters have the following performance:

Isolation: between adjacent channels 60 dB, at 1% frequency spacing
Insertion loss: not greater than 2 dB per channel
Band width: ±50 kHz min to 2 dB points
Power rating: 100 W
Impedance: 50 ohm
VSWR: typically 1·5 or better
Temperature range: operating 0°C to +50°C; storage –30°C to +70°C; relative humidity 90%
MTBF: manual version greater than 20 000 h; autotune version 2000 h
Intermodulation levels: –140 dB below 100 W for third-order two-channel products

Airtech antenna multicoupler for the 225–400 MHz band (auto and manual types shown)

Connectors

A series of high-performance connectors has been developed for the multicoupler system incorporating low intermodulation contacts and high-accuracy terminations which include:

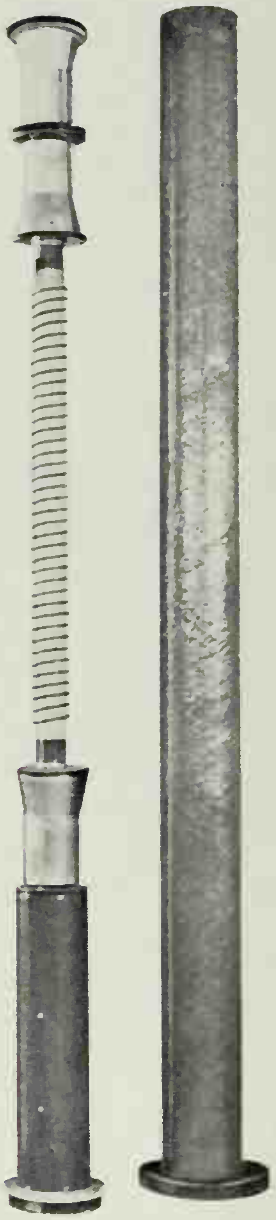
a) Thruline coupler for interconnecting filters, b) Short-circuit termination, c) Thruline extensions, d) 50-ohm terminations, e) Antenna connectors. Brief details of their performance are as follows:

Intermodulation levels: –140 dB below 100 W for third order two-channel products as above
Impedance: 50 ohm

Antennae

Airtech Ltd has developed low intermodulation antennae for use with the multicoupler system so that full advantage may be taken of the flexibility offered by multicoupling. The following is a brief specification of the Type 246-2 dual antenna:

Isolation between upper and lower sections: 40 dB
Frequency range: 225–400 mHz
Gain: unity, each section
Polarisation: horizontal (azimuth pattern); circular within ±1 dB; vertical (elevation) beam width approx 83° each section
Impedance: 50 ohm
VSWR: 2 max
Power rating: 2 kW per section
Height: 2·9 m (9 ft 6 in)
Diameter: 0·34 m (13½ in)
Weight: 40·8 kg (90 lb)
Design wind velocity: with 25 mm (1 in) radial ice 193 km/h (120 mph)
Pressurisation if required: 1 kgf/cm^2 (15 lbf/in^2)



Airtech omnidirectional antenna for the 225–400 MHz band (includes two separate broadband dipoles)

AIRTECH LIMITED
Haddenham, Aylesbury, Buckinghamshire, England
Telephone: Haddenham 422 Cables: Airtech Haddenham Telex: 83223

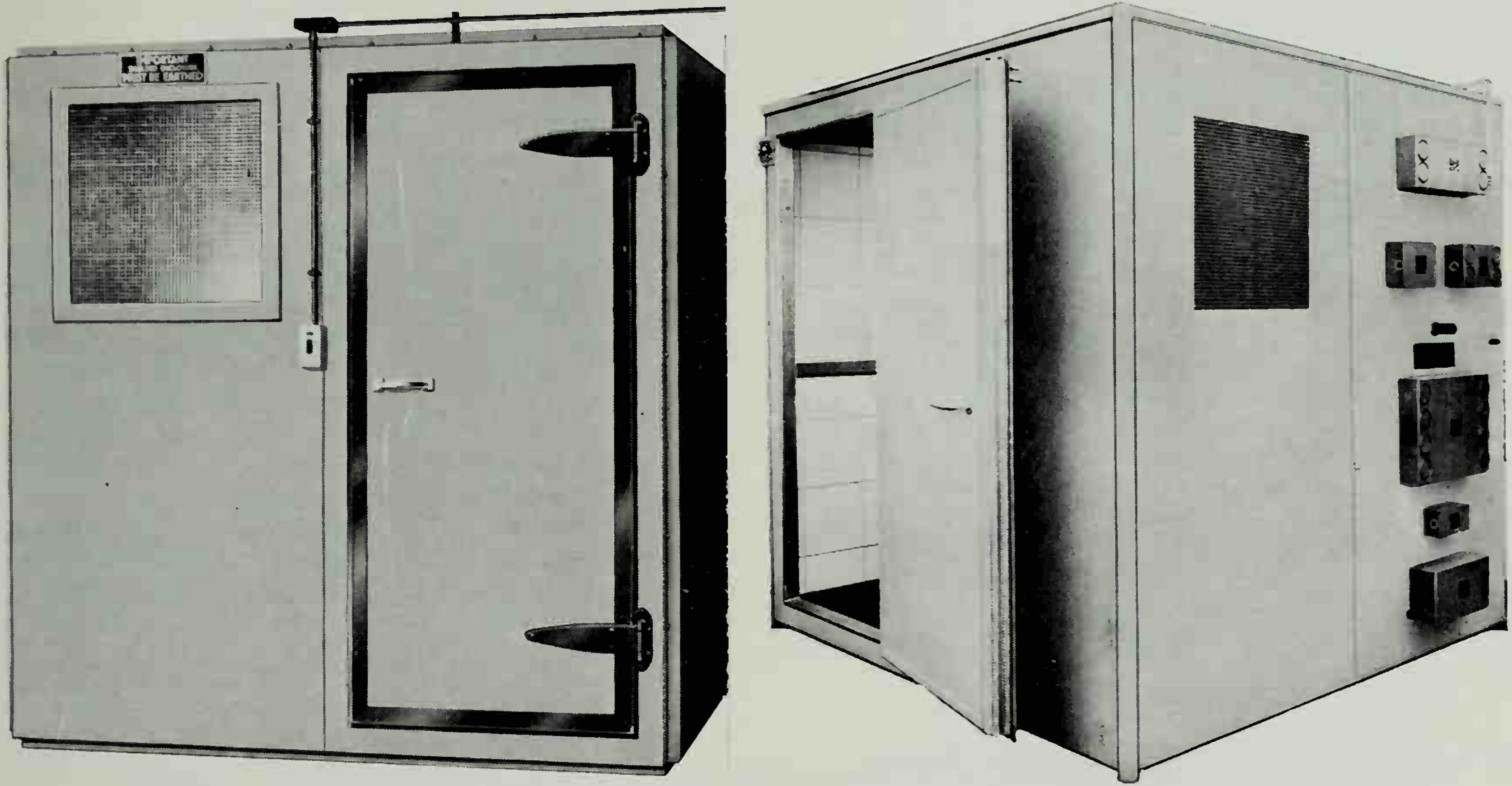
AIRTECH

Shielded enclosures

for protection against radio frequency interference

In many fields of electronics it is frequently necessary to prevent or reduce the emission of radiation or to provide a quiet zone in electro-magnetic terms. These requirements are met by the use of RFI (radio frequency interference) shielded enclosures.

The increasing sensitivity of modern electronic equipment and the high levels of RFI now prevalent call for shielded enclosures offering a high degree of isolation (attenuation) over a very wide frequency spectrum.



Above: Two typical high-performance L2000 modular enclosures. Larger enclosures are available

Belling & Lee Ltd offers two solutions:

1. A prefabricated free-standing, internally bolted, modular enclosure providing high performance over a wide frequency range. Generally suitable for maintenance workshops and communications centres. Can be erected by unskilled personnel.
2. A specially designed and manufactured enclosure offering a higher performance over a wider frequency range and providing protection for a complete room.

For both types of shielded enclosures comprehensive mains and signal line filters are available together with ventilation and air-conditioning systems and other ancillaries.

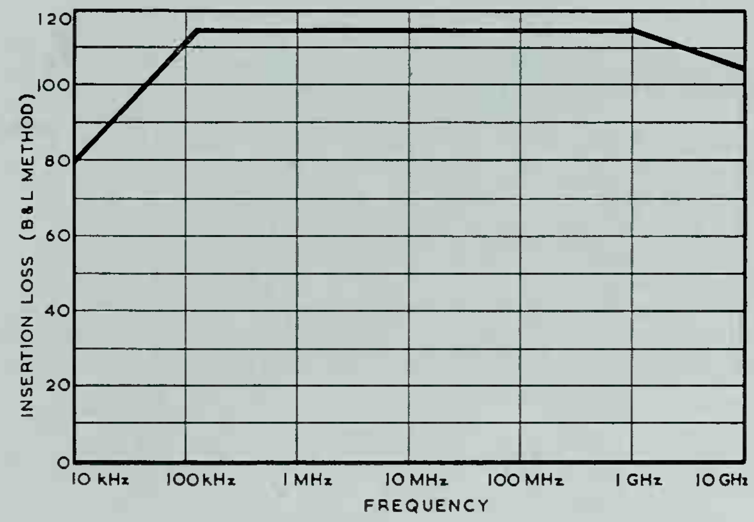
A complete 'turn-key' service is offered with design, manufacture, installation and testing if needed.

Some typical applications for these enclosures, which are in service throughout the world in British, NATO, CENTO, SEATO and other forces, include communication centres, maintenance workshops, computer rooms, communications security, military hospitals, signals research establishments and training centres.

Specification: L2000 modular enclosure

Basic shielding: 0·56 mm (0·022 in) plated steel
Module size: 2235 mm × 1118 mm (7 ft 4 in × 3 ft 8 in)
Door aperture: 1981 mm × 876 mm (6 ft 6 in × 2 ft 10½ in) clear opening. The door can be left- or right-hand hinged
Ventilation: by reversible-flow variable-speed 299 mm (9 in) dia fans internally mounted in conjunction with special Attenuvent units
Air conditioning: external or internal units can be incorporated
Floor: lino tiled wooden over shielding
Construction: internal bolting
Range: various sizes, details on request

Below: Typical insertion loss of Belling & Lee L2000 shielded enclosure



BELLING AND LEE LIMITED
Radio Frequency Interference Division
Great Cambridge Road, Enfield, Middlesex, England
Telephone: 01-363 5393 Cables: Radiobel Enfield
Telex: 263265

Miniature recorder

Airborne tape cassette record/replay equipment

Type 1200 voice recorder

Davall developed the Type 1200 voice recorder/reproducer expressly for mounting in the cockpit of the Harrier, but it is now also installed in the Buccaneer and Jaguar, and other advanced military aricraft.

This recorder has been so miniaturised that the complete recorder fits into the space previously occupied by the recorder control panel. It is hard-mounted in the cockpit within easy reach of the pilot or other crew member, who can change the cassette in flight if necessary.

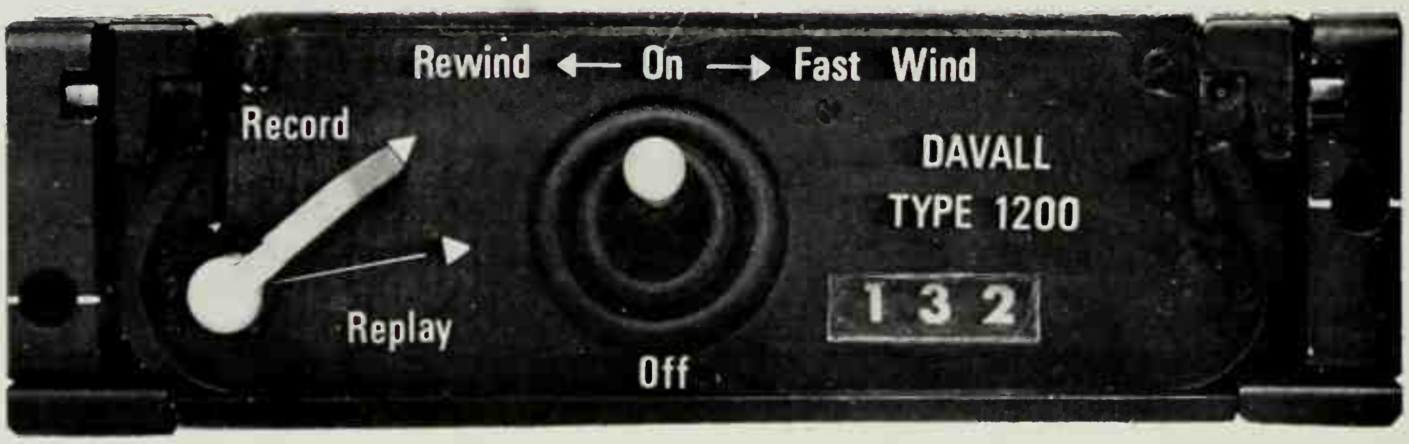
When connected to the aircraft central communications system, it provides facilities for recording and replaying intelligible speech under the most severe environmental conditions envisaged for fighter-reconnaissance aircraft. The ability to replay in the air enables the aircrew to edit the recording, replay air traffic instructions, and listen to instructions previously recorded on the ground, such as sealed flight directions and check lists. It is also possible to transmit a recording from the aircraft by replaying the record with the R/T transmit button pressed.

All controls are mounted on the small top panel and consist of a joystick for 'On', 'Off', 'Rewind' and 'Fast Forward' and a separate switch for 'Record/Replay'. A three-figure digital indicator is visible through a window on the right of the panel; this returns to zero each time the Philips cassette is removed. The panel is illuminated internally by a separately switched 28 V supply, so that the panel is illuminated even though the recorder may be switched off.

The recorder incorporates an automatic start when switched to 'Record': it is actuated by an incoming audio signal and switches off automatically at a preset time after the cessation of signals; both the start level and the over-run time may be adjusted by preset controls. This automatic switching of the recorder gives maximum economy in the use of tape since there is almost no blank tape, which in turn means economy of time during replay. With a continuously running tape there are often long periods of silence between recorded messages.

The Type 1200 recorder/reproducer uses standard commercial Philips cassettes. Playback may take place on the Type 1200 or on any low-cost commercial recorder utilising the Philips cassette system.

Special models of the Type 1200 recorder have been produced with data recording facilities in addition to voice. Variations of the design can be produced to meet customers' individual requirements.



Actual size of complete recorder

Specification

Size: 14·7 × 4·3 cm (panel) × 16·8 cm deep (5·8 × 1·7 × 6·6 in)
Fixing: hard-mounted, to Arinc specification
Weight: 1·36 kg (3 lb)
Colour: matt black
Power supply: 28 V dc to BS 2 G100 P.3
Power consumption: 10 W max
Connector: Hellermann Deutsch, Type SLPT-OOE-14-19P
Tape cassette: Philips compact type C.60 (30 min per track, two-track system), C 90 (45 min per track) and C.120 (60 min per track), metal cassette available
Tape speed: 48 mm/sec (1⅞ in/sec)
Tape indicator: digital counter indicates tape used, automatically reset when cassette is removed
Controls: joy-stick for 'on', 'off', 'rewind' and 'fast wind'. Separate 'record/replay' switch
Recorder control: recorder is automatically started by audio input and stops after a preselected silence time. Input trigger level and time delay adjusted by preset controls
Monitor: side-tone generated when recording ceases at end of tape or on tape break (photo-electric detector)

A member of the Bentima Group
S DAVALL & SONS LIMITED
Wadsworth Road, Greenford, Middlesex, England
Telephone: 01-998 1011 Cables: Davall Greenford

DAVALL

Recording equipment

for voice and data on magnetic tape

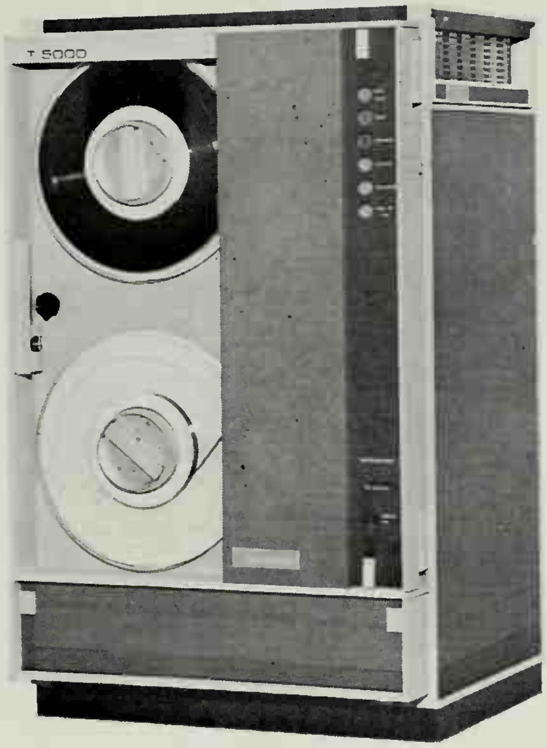
Series VII 34-channel communications recorder

This twin-bay all-solid-state communications recorder offers high packing density with maximum security of recordings, time injection by 'speaking clock' eliminating the need for Morse knowledge, and gives maximum tape economy, recording for up to 12 hours per tape spool.

A complete set of record and monitor electronics is supplied to each tape transport, with automatic changeover on the occurrence of a fault. A pilot tone at 3500 Hz is recorded on each channel, and these are monitored sequentially each 2·5 seconds for recording fault or deterioration. Full use is made of integrated circuits, no relays being used, and brushless motors are used. The design life of the equipment is ten years, and reliable recordings will be obtained throughout this life, on a 24-hour basis.

Specification

No of channels: 34 on a 2·54 cm (1 in) tape
Tape speed: 2·375 cm ($\frac{15}{16}$ in) per second
Frequency response: 300–3000 Hz ±3 dB
Auto gain control: 50 dB input change gives 3 dB output change
Input sensitivity: –28 dBm to +10 dBm (without agc)
Input impedance: >20 kilohms unbalanced, approximately 600 ohms balanced
Signal-to-noise ratio: greater than 40 dB
Cross talk: >–40 dB related to normal signal level
Distortion: < 1% at full rated output
Wow and flutter: 1% at 0·5–200 Hz
Recording time: 8 h 32 min on double-play tape, 12 h 45 min on triple-play tape
Power supplies: 100–250 V 50 or 60 Hz, 150 VA
Environment: 0°C to +50°C up to 90% rh



T5000 incremental magnetic recording systems

The T5000 recording system has been designed to fulfil the need for data recording in an IBM/Industry format, and to give the maximum of flexibility with the minimum of superfluous logic. The tape transports are built to computer tape-handler standards; high reliability and long life are guaranteed by solid-state modular construction combined with maximum use of integrated circuits.

The T5000 may be used as an intermediate store between data source and computer, or as a computer-backing store. It is ideally suited for a wide range of applications in data-logging and wherever large amounts of raw or processed data must be stored temporarily or permanently.

Specification

Format: 7 or 9 track
Packing density: 200, 556 or 800 binary digits per in (bpi)
Feed modes: incremental on command or 95·25 cm (37·5 in) per sec continuous
Increment rate: 0–300 characters/sec at 200 and 556 bpi
  0–500 characters/sec at 800 bpi (up to 1200 characters/sec to special order)
Start time: 2 msec at 95·25 cm/sec
IRG generation: 37 msec including writing LCR
Operating temperature: 0°C to +50°C
Relative humidity: 85% maximum
Dimensions: 77 × 49 × 43 cm (30¼ × 19¼ × 16¾ in)
Weight: 80 kg (170 lb) approximately

RACAL-THERMIONIC LIMITED
Hythe, Southampton, Hampshire, England
Telephone: Hythe 3265 Cables: Technico Hythe Telex: 47600

RACAL

Magnetic tape recorders

digital, incremental/continuous, read/write

These machines are compact, inexpensive and highly reliable, and are being increasingly used on military projects.

The tape transport and head are mounted on a heavy machined casting. Stainless steel ball bearing tape guides (sealed for life) and three heavy-duty high-torque printed motors are used, the latter requiring no lubrication. The buffers are so designed that alignment or re-adjustment is not required.

Maintenance is simplified by clean layout and the absence of terminal strips; all sub-assemblies are interconnected by heavy-duty connectors and electronic circuit modules are on plug-in cards.

There are two basic units: the MTD 10 000 can operate continuously or incrementally, while the MTD 10 500 is a continuously operating model. Both are available as 7 or 9 track machines and as read-only, write-only or read/write versions.

rdl
RECORDING DESIGNS LIMITED
SERIES 10000

Specification

MTD 10 000

Recording speeds: 0–1000 steps/sec at 320 bits/cm (800 b/in), (optionally 0–6000 steps/sec) incremental; 10–95 cm/sec (4–37·5 in/sec), (conditionally 10–190 cm/sec) bi-directional, max data rate 30 000 characters/sec (up to 60 000 characters/sec conditional) in continuous mode

Reading speeds: as recording in continuous mode

No. of tracks: 7 (IBM 729 Series spacing) or 9 ASC 11 (IBM 2400 Series spacing)

Heads: 2 heads standard for read/write (dual-gap head optional)

Recording densities: 320, 220 or 80 bits/cm (800, 556 or 200 bits/in) 7 and 9 track (NRZI)

Rewind time: less than 1·5 min, capstan-controlled, for 360 m (1200 ft)

Tape: 12·7 mm (0·5 in) computer tape

Reels: 217 or 266 mm (8·5 or 10·5 in) dia, IBM hub

Dimensions: 483 × 308 × 311 mm (19 × 12¼ × 13¼ n) with 216 mm reels, 484 × 621 × 311 mm (19 × 24½ × 13¼ in) with 266 mm reels

Weight: 34·5 kg (76 lb) with 216 mm reels, 68 kg (150 lb) with 266 mm reels

Temperature range, operating: 0°C to +55°C, 5–95% RH

Power: 105–250 V ±5%, 47–64 Hz (400 Hz optional), consumption 150 VA quiescent, 750 VA (266 mm reels) max

Input: DTL input gates (0 to ±0·5 V true, +3·5 to +8 V false), inverted logic available; commands: 6 or 8 lines data, parity, general reset, forward reverse, write disable, tape mark gap, inter-block gap, erase (optional)

Output: DTL power gates (0 to + 0·5 V true, +3·5 to +5·5 V false), inverted logic available; commands: 6 or 8 lines data, recorder pulse, read data clock, gap in progress, buffer busy, all-zero inputs, echo parity (optional); status: write ring present, write enabled, ready, beginning of tape, end of tape, tape not tensioned

Controls: on/off, load forward, rewind, ready, tape mark gap (remotely controllable, except on/off)

Parity check: line signal from data source or integrally generated (standard), true echo parity (optional)

Error check facility: longitudinal redundancy check character on all models (cyclic redundancy check character optional on 9-track models)

Also available: write-only and read-only models

MTD 10 500

Transport speeds: 10–95 cm/sec (4–37·5 in/sec bi-directional, conditional up to 190 cm/sec (75 in/sec), optionally down to 2·5 cm/sec (1 in/sec); stop *and* start within one inter-block gap at 95 cm/sec, stop *or* start within one interblock gap at 190 cm/sec

Instantaneous speed variation: less than ±3%

Long-term speed variation: less than ±1%

No of tracks: 7 or 9, computer-compatible spacing

Heads: 2 heads standard for read/write (dual-gap head optional)

Recording densities: 320, 220 or 80 bits/cm (800, 556 or 200 bits/in)

Start and stop time: less than 20 msec for any speed between 10 and 95 cm/sec

Turn-around time: 100 msec at 95 cm/sec (500 msec at 190 cm/sec); no delay below 63 cm/sec (25 in/sec)

Rewind time: less than 2 min standard for 360 m (1200 ft) tape

Tape: 12·7 mm (0·5 in) computer tape

Reels: 216 or 266 mm (8·5 or 10·5 in) dia, IBM hub

Dimensions: 483 × 308 × 311 mm (19 × 12¼ × 13¼ in) with 216 mm reels, 484 × 621 × 311 mm (19 × 24½ × 13¼ in) with 266 mm reels

Weight: 34·5 kg (76 lb) with 216 mm reels, 68 kg (150 lb) with 266 mm reels

Temperature range, operating: 0°C to +55°C, 5–95% RH

Power: 105–250 V ±5%, 47–64 Hz (400 Hz optional), consumption 150 VA quiescent, 750 VA (266 mm reels) max

Imput: DTL input gates (0 to +0·5 V true, +3·5 to +8 V false), inverted logic available; commands: 6 or 8 lines data, parity, write data clock, write disable, general reset, rewind, forward, reverse, go/stop, write enable, disable manual controls, select line, enable longitudinal and/or cyclic redundancy check

Output: 6 or 8 lines data, parity, read data clock, echo parity (optional); status: write ring present, write enabled, beginning of tape, end of tape, tape not tensioned

Controls: on/off, load, rewind (local or remote)

Error check facilities: longitudinal redundancy check character (standard), cyclic redundancy check character (optional)

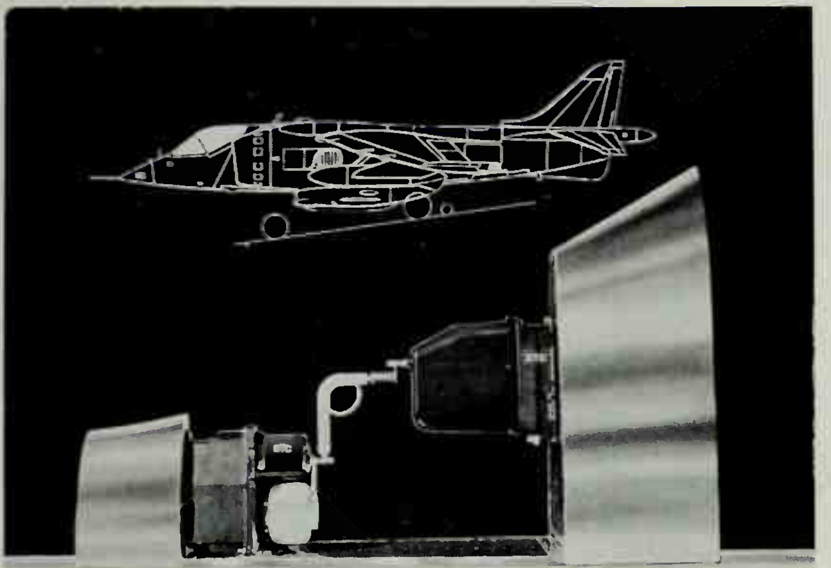
Also available: write-only and read-only models

RECORDING DESIGNS LIMITED

Blackwater Station Estate, Blackwater, Camberley, Surrey, England
Telephone: Camberley 24622 Telex: 85272

Aircraft communications

Airborne and ground equipment

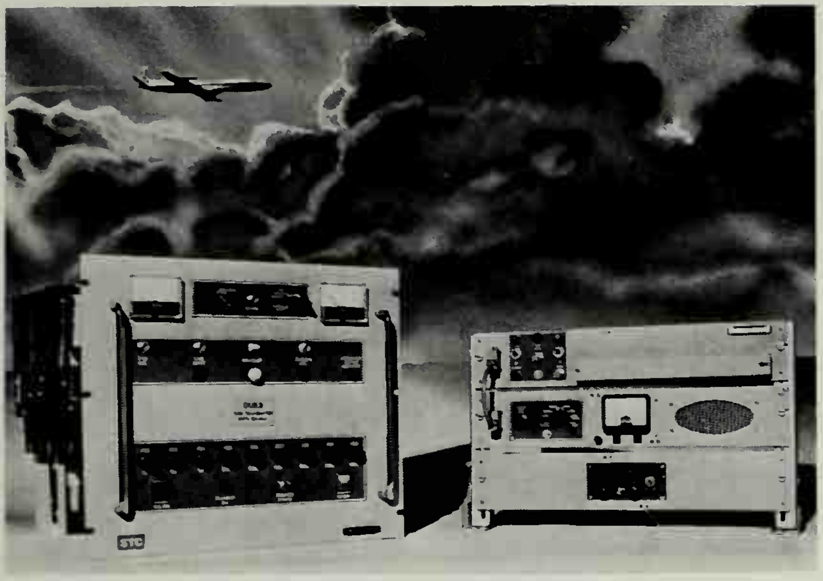


Notch aerial system AN.13 HF as supplied for the Hawker Siddeley *Harrier*

Aircraft aerials

For many years STC has been engaged in the design and manufacture of aerials for all types of aircraft, civil, military, subsonic and supersonic. The STC aircraft aerial consultancy service advises aircraft manufacturers and operators on aerial siting and installation. The range of aerials available includes units for air traffic control (ATC), distance measuring equipment (DME) and equipment for identification of friend or foe (IFF), instrument landing systems (ILS) glide slope determination, ILS/VOR, suppressed HF notch equipment, tactical air navigation (TACAN) systems, telemetry, UHF, VHF and UHF/VHF communications equipment and radio altimeters.

Aerials are type-tested in accordance with the environmental requirements of specifications AVP.24, K.114, and BS 2G.100.



DU.8-B VHF transmitter (*left*) and RX.25-A VHF receiver (*right*)

Ground-to-air communications

DU.8-Series transmitters

DU.8 transmitters are crystal-controlled amplitude-modulated single-frequency VHF and UHF equipments primarily intended for ground-to-air communication.

Technical data

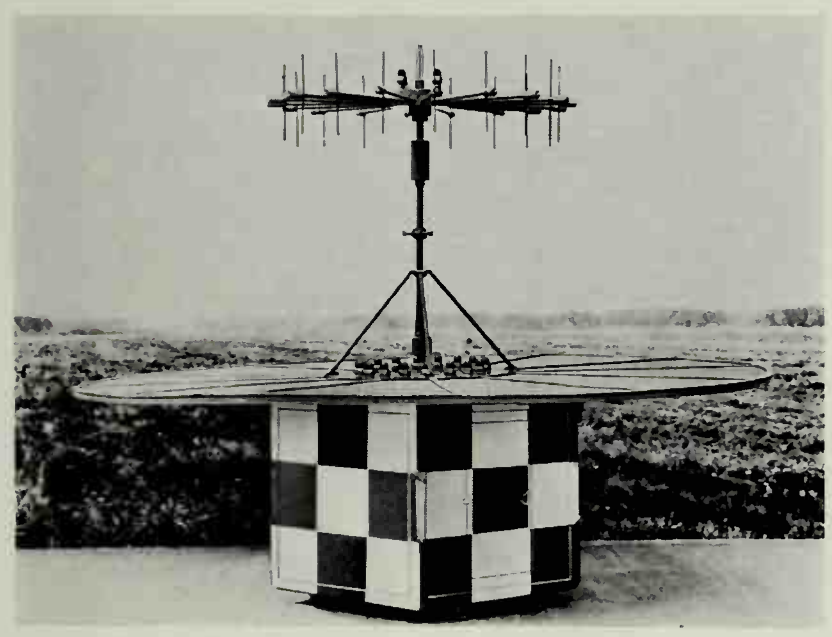
DU.8-A 10 W, 100–156 MHz fully transistorised
DU.8-B 70 W, 100–156 MHz conductor-cooled output valves
DU.8-D 90 W, 225–400 MHz conductor-cooled output valves

RX.25 Series receivers

The RX.25 series amplitude-modulated fully transistorised receivers is designed primarily for ground-to-air communications.

Technical data

RX.25-A 100–156 MHz
RX.25-B 225–400 MHz
Fully transistorised, wide range of ancillary units available



SGDF.10-A VHF/UHF direction finder

Ground direction finder

The SGDF.10-A ground direction finder is a new solid-state unit for VHF and UHF operation. It has been designed to give maximum suppression of site errors due to wave scattering obstacles.

Technical data

Fully transistorised—no moving parts
Frequency coverage 100–156 MHz; 225–400 MHz
1–10 operational positions
1–10 operational frequencies

An associate of ITT
STANDARD TELEPHONES & CABLES LTD
Radio Products Group
Oakleigh Road, New Southgate, London, N11, England
Telephone: 01-368 1200   Telex: 261912

STC

Telecommunication headsets with boom-mounted microphones

Airlite lightweight headsets for airborne, seagoing and ground control communications.

Airlite 62: already adopted as standard equipment by over fifty major airlines and armed services, is available with a choice of carbon or moving-coil (mc) microphones, with or without the exclusive quick-attachment points for the Airmed range of oxygen masks with chain toggle harness suspension.

Airlite 70: available with mc differential or electro-magnetic (em) pressure microphones of varying impedance.

As an alternative to the carbon microphone a miniature thin-film amplifier may be fitted for use in conjunction with mc or em microphones to provide high-quality transmission through equipment designed for carbon microphones.

Airmed Ltd
Edinburgh Way, Harlow, Essex, England
Telephone: Harlow 24331
Cables: Airmed Harlow
Telex: 81338

Ferrograph magnetic tape audio recording equipment

The Series Y range of professional magnetic tape recorders, specially designed for sound and instrumentation recording, are available in single- and two-channel form, both recording in the half-track mode on 6·35 mm (¼-inch) tape; a full-track model, the Y715H, is also available.

Recording speeds of 38, 19, 9·5, 4·75 and 2·38 cm/sec (15, 7½, 3¾, 1⅞ and 15/16 in/sec) are available in various combinations.

Ferrograph recorders are widely used by military and civil authorities in many parts of the world for recording voice transmissions and audio signals.

The Y Series may be operated either in the horizontal or vertical position, free-standing or mounted in standard 482 mm (19-inch) racks. The recorders are housed in robust metal cabinets.

The Ferrograph Company Ltd
The Hyde, Edgware Road, Colindale, London NW9, England
Telephone: 01-205 2241
Cables: Britferro London NW9

Thyristor for pulse modulator and similar applications

The U1188/x range of thyristors is designed for use in radar pulse modulators and similar applications where high-current amplitude, short-duration pulses are required or where there is a large ratio of peak-to-mean current.

The high peak-to-mean current ratio which may be catered for is shown by the maximum repetitive peak current and mean ratings which are 1000 A and 30 A respectively. Maximum repetitive di/dt capability is 1200 A/μs. Typical current rise time from 400 V into 300 A is 300 ns, with $I_G = 4$ A at 0·1 μs rise time.

Voltage-blocking capability in both directions and the forward breakover voltage ratings and the transient reverse voltage rating have the same value. Voltage classifications are available up to 600 V.

Westinghouse Brake and Signal Co Ltd
82 York Way, King's Cross London N1, England
Telephone: 01-837 6432
Cables: Westinghouse London N1
Telex: 261629

Section 26

Training equipment

Receiving installation

BACKGROUND/
SIGNAL
STRENGTH
MISS DISTANCE—FEET
OPERATE
SIGNAL
STRENGTH
SOURCE LEVEL
SELF
TEST
1
2
3
RESET
ON
OFF
INDICATOR UNIT

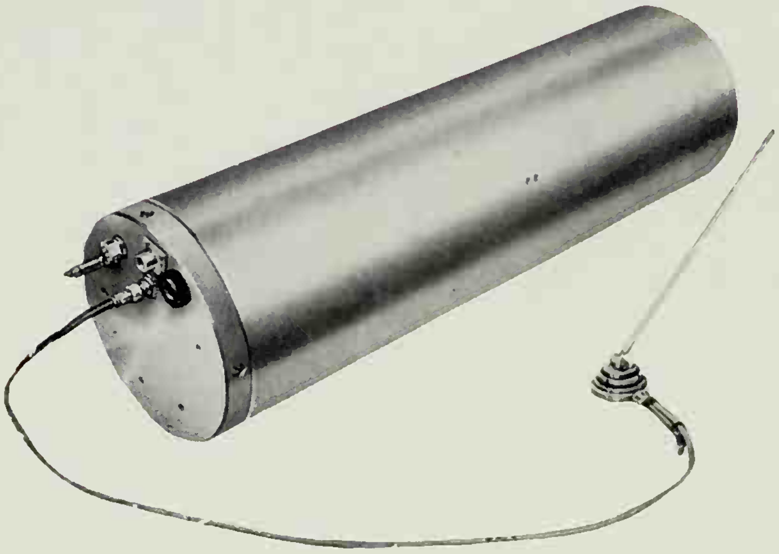
RMDI indicator

Telemetry receiver, data processors 1 and 2 (all types)

INNER
MIDDLE
OUTER
SPARE
RESET
TEST
OPERATE
ON
OFF

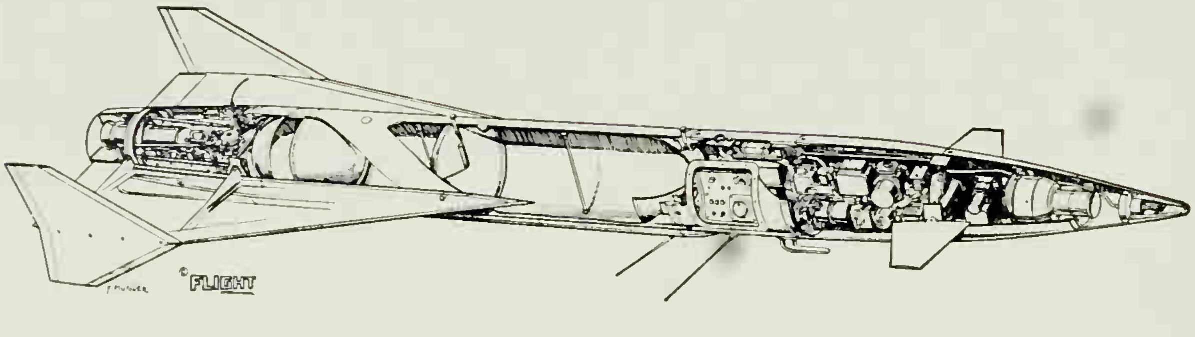
AMDI indicator

Target installation (RMDI)



E245 Detector/Electronics unit, telemetry aerial

E265 Detector/Electronic units



E265 installation in nose tip of Stiletto target drone

Miss-distance systems

for guided weapons and projectiles

The Ekco MDI (miss-distance indication) systems were developed to measure and indicate the miss-distance of guided missiles and projectiles fired against all types of practice targets. There are two basic Ekco MDI systems:

High-accuracy radioactive system E245 (RMDI) for missiles

This system measures, at the target, the electromagnetic power from a small radioactive source fitted to the missile and gives a distance readout.

The RMDI system has a standard range of 0–15 m (0–50 ft), but equipment with a range of 0–30 m (0–100 ft) can be supplied to special order.

The E265 is a modular version of the RMDI system with a very compact detector/electronics unit for fitting in supersonic targets.

The advantages of the Ekco RMDI system are:
Specialist interpretation of photographs is not required, as with radar and kine-theodolite systems.
Results are available immediately, giving lower training cost and more confidence to operators.
The equipment is mobile.
All units are simple to maintain.
The Ekco system is far less expensive than competitive systems.

Acoustic system E246 (AMDI) for shells

This system measures amplitude of the shock wave generated by the shell and counts the number of shots passing through defined zones around the target.

The system is fully proven in operational conditions.

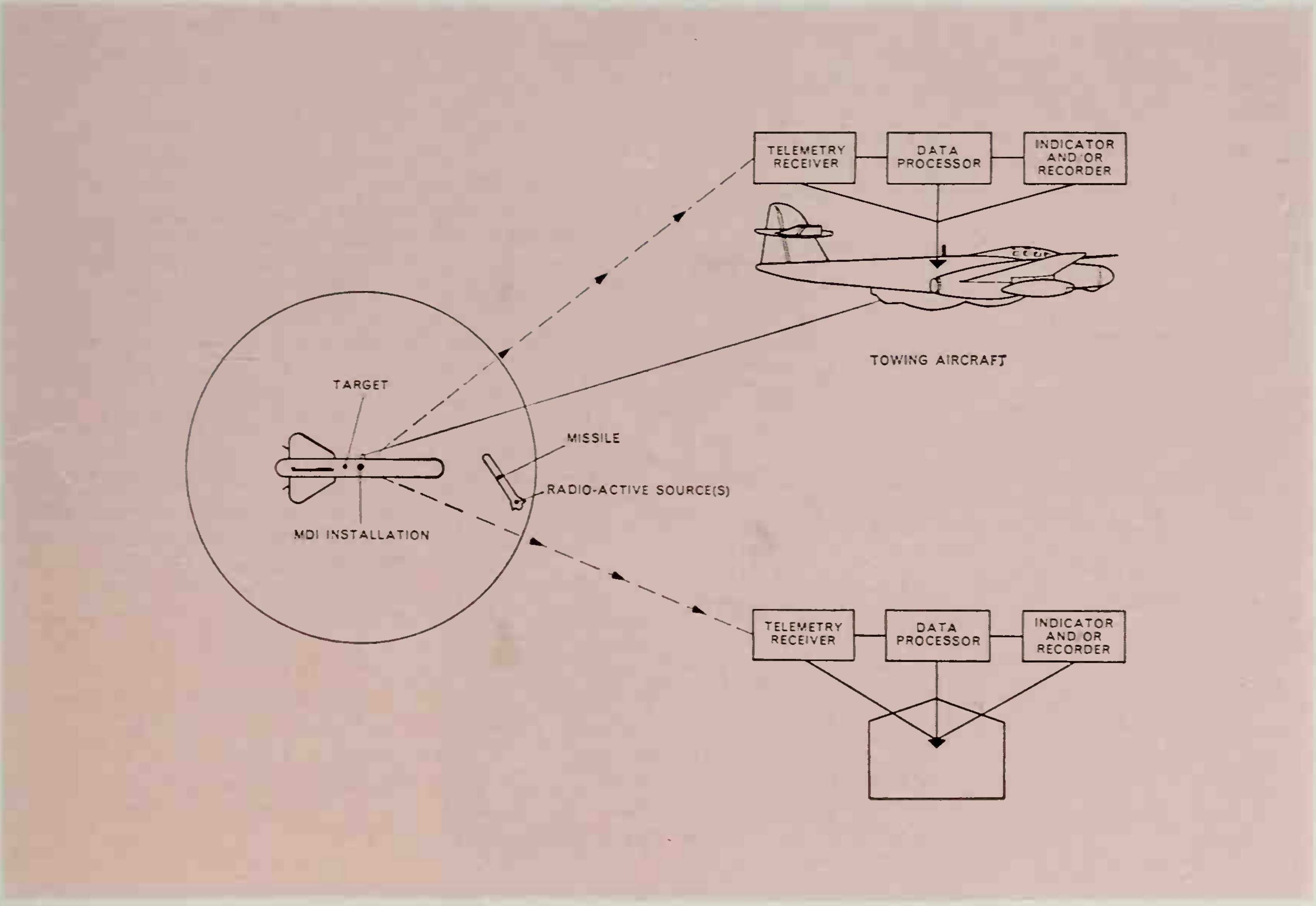
The ADMI system has an overall range of 0–30 m (0–100 ft) in three zones of 0–7·5 m, 7·5–15 m and 15–30 m (0–25 ft, 25–50 ft and 50–100 ft).

Both systems are available for towed, drone and missile targets.

Ekco MDI systems were developed in association with the Royal Aircraft Establishment, Farnborough, England, and after extensive flight trials are now specified for service with the British armed services.

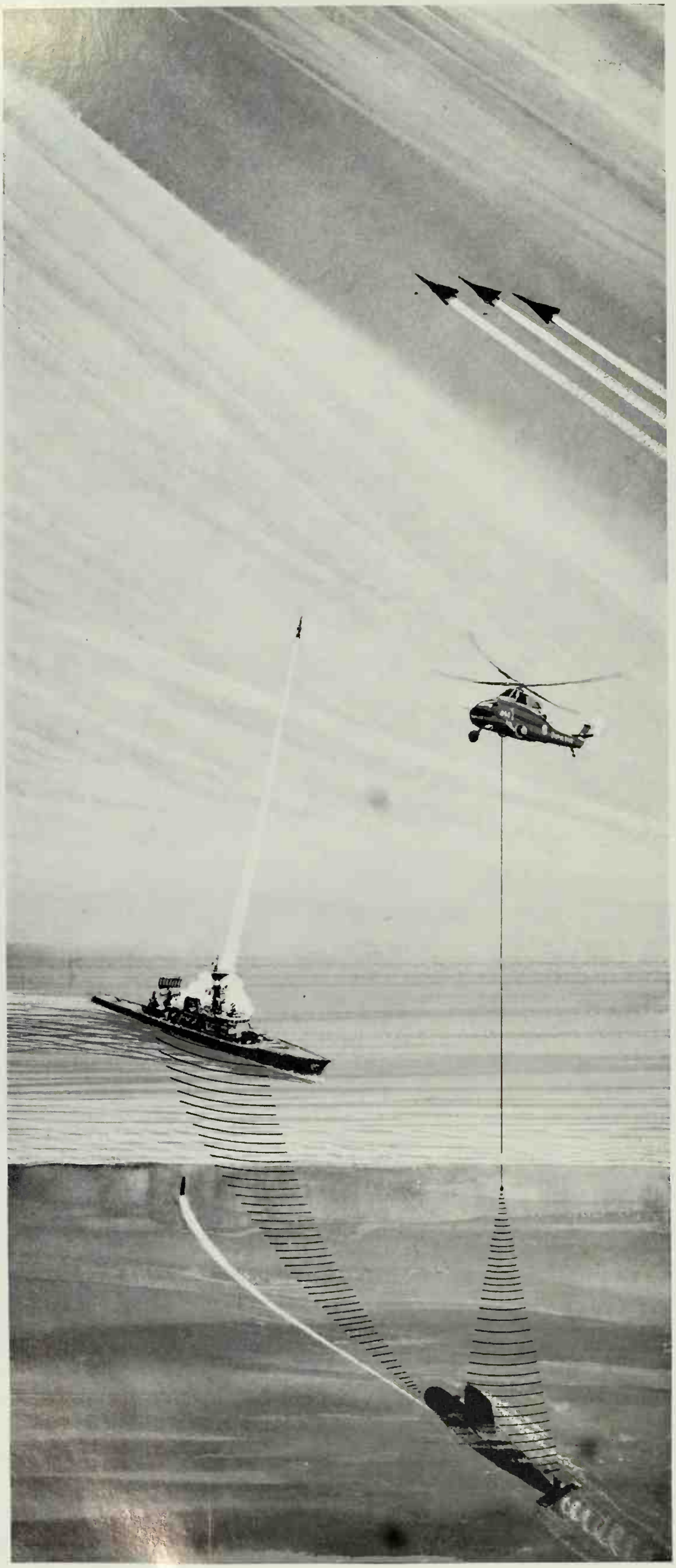
Ekco Avionics is responsible for marketing these systems which have been developed by Ekco Instruments Ltd.

Other Ekco and Pye products are described elsewhere in this Catalogue.



System principles: RMDI with towed target

EKCO AVIONICS
A Division of Pye Telecommunications Ltd
Southend-on-Sea, Essex, SS2 6PW, England
Telephone: Southend-on-Sea 49491 Cables: Ekco Southend Telex: 99167



Fighter controllers, radar simulation, raw, synthetic, clutter, E/W, intercept profiles

Missile controllers, radar simulation, raw, synthetic, clutter, E/W

Anti-submarine helicopters, environmental simulation, sonar raw, noise, synthetic plot

Tactical trainers, all-purpose cubicles command training, tactical plot display probability, sensor ranges, background synthetics

Submarine trainers, environmental simulation, attack periscope, optical/electronic sonar simulation

Weapon control, torpedo control, immediate post-firing analysis on tabular displays

Trainers and simulators

based on microminiature digital computers

Why trainers?

Real exercises cannot be staged very frequently. They are expensive and require a massive effort in planning and organisation. It is sometimes impossible to provide air, surface and subsurface forces of the required type or number, and the presence of unwelcome observers at every big exercise precludes realistic training in aspects such as electronic warfare. For these and other reasons there is a requirement for shore trainers which enable exercises and tactical investigations to be carried out, particularly in those areas which present special difficulties in real exercises. Finally, trainers can provide facilities for immediate post exercise analysis, so that lessons can be appreciated while the experience is still fresh.

Why digital?

In each of these types of trainer the system must be based on a versatile, and often powerful, computing system. In the past analogue machines have been used, but systems based on analogue computing power require a unique channel for each track and in a practical system this can vary from 15 to 150 channels. Analogue systems are therefore expensive and, since each channel requires extensive re-adjustment in changing from exercise to exercise, they are time-consuming to set up. They also present a formidable maintenance load. Ferranti trainers are therefore based on advanced microminiature digital computers and associated equipment taken from the standard Ferranti range.

Action speed tactical trainers

Action speed tactical trainers are used for the teaching and development of tactics at command team level. An ASTT typically comprises a number of students rooms or cubicles which can from excercise to exercise represent any kind of seaborne, airborne or subsurface vehicle, and a monitor room from which the exercise is controlled. The students' and monitors' rooms are equipped with CRT displays normally giving simplified plan and tabular information, and with communications facilities. Students' rooms also have standard control facilities by which the movement, sensors and weapons of the vehicle represented are controlled. Monitors are equipped with special controls by which the performance of vehicles represented by cubicles can be altered, for example to simulate the result of damage assigned after a simulated engagement, and by which other parameters relevant to the conduct of the exercise can be varied. Post-exercise analysis facilities are also provided.

Helicopter anti-submarine trainers

These are used for the training of helicopter sonar operators and observers. They involve the realistic environmental simulation of the appropriate helicopter compartments, fitted with sonar, radar and navigation equipments, and the generation of realistic information as presented by these equipments. Multi-helicopter trainers, enabling joint exercises to be carried out, are available.

Missile controller trainers

The purpose of missile controller trainers is to provide missile controllers with a simulated environment representative of the normal method of presentation of information and of the usual communications and control facilities. Such simulators can involve the generation of 'raw radar' displays and the realistic simulation of electronic warfare effects.

Fighter controller trainers

Fighter controller and air traffic controller trainers are provided. These trainers demand the realistic simulation of background air situations including the generation of raw radar echoes for typically 10 to 80 aircraft, together with clutter and other effects, and the provision of displays and controls representative of those used in real control rooms. Exercises are controlled by a number of monitors who are responsible for the pilot responses for aircraft under control.

Submarine crew trainers

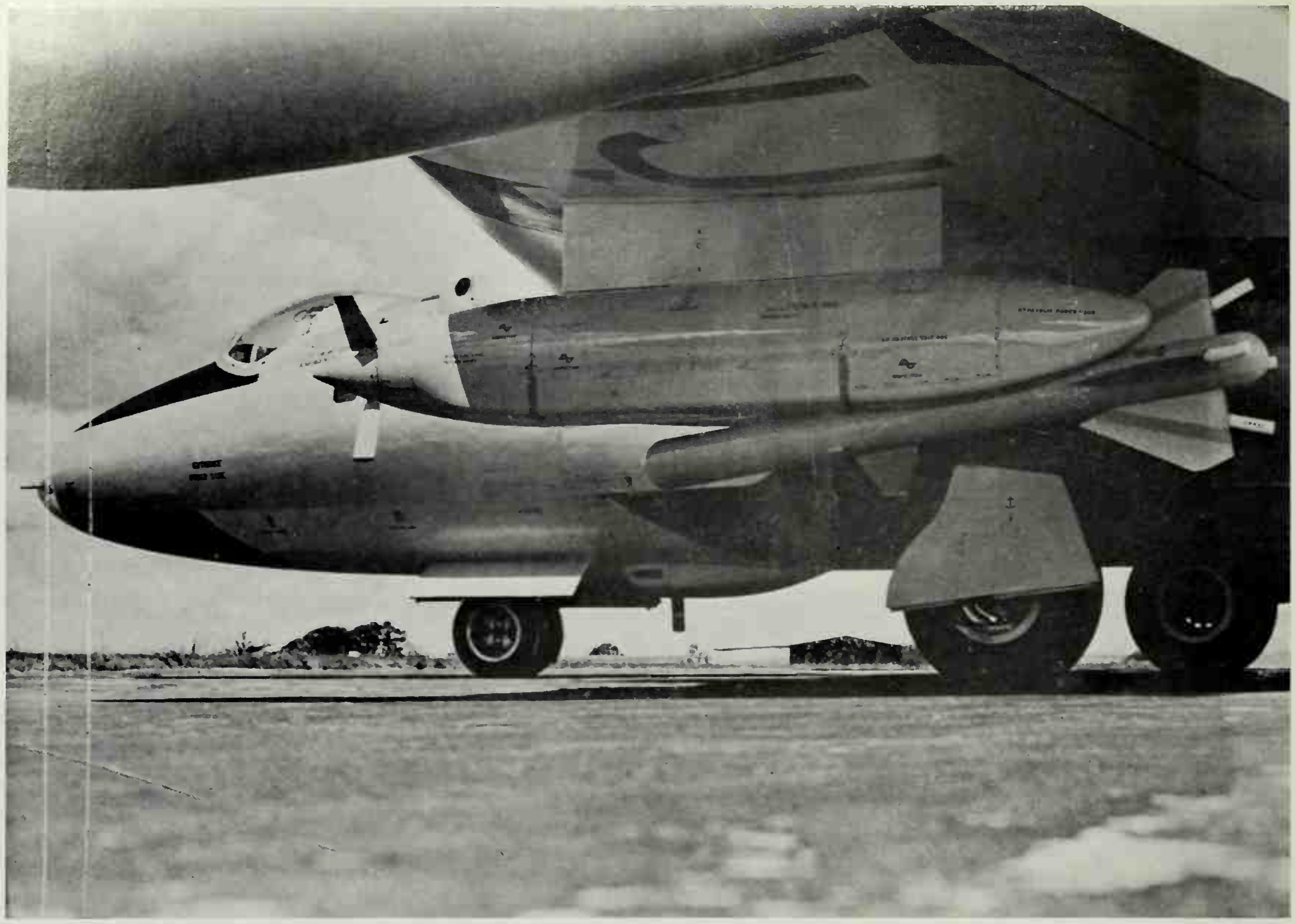
Multiple submarine trainers are available which provide facilities for individual crew training in sonar and/or torpedo fire control operations and have facilities for tactical training in which the crews may partake in joint exercises. These trainers involve the realistic simulation of surface vessels as seen through each submarine periscope. This is achieved by advanced computer-controlled television techniques.

ASW command and operator trainers

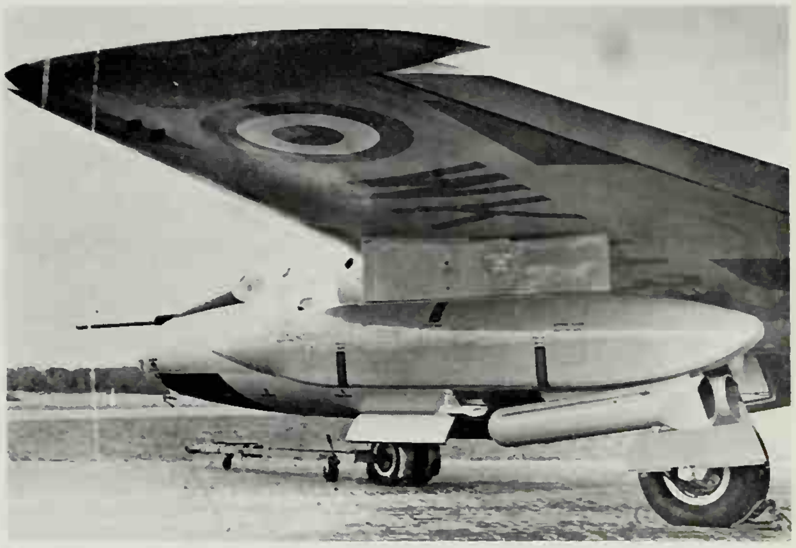
ASW command and operator trainers are used for the training in anti-submarine warfare of sonar operators and command teams of one ship, or of more ships in co-ordinated exercises. Such trainers involve the realistic simulation of facilities in sonar control rooms and operations rooms, and the provision of instructor/monitor facilities.

FERRANTI LIMITED
Government Contracts Department
Hollinwood, Lancashire, England
Telephone: 061-681 2000 Telex: 66342

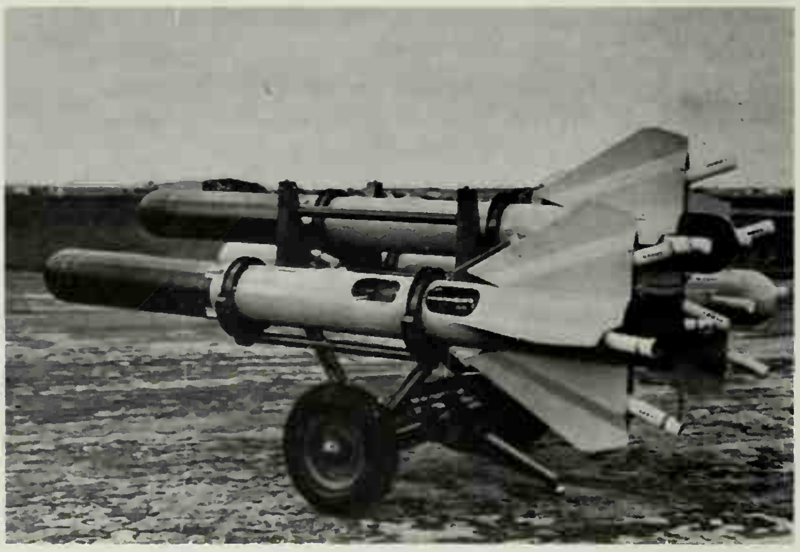
FERRANTI



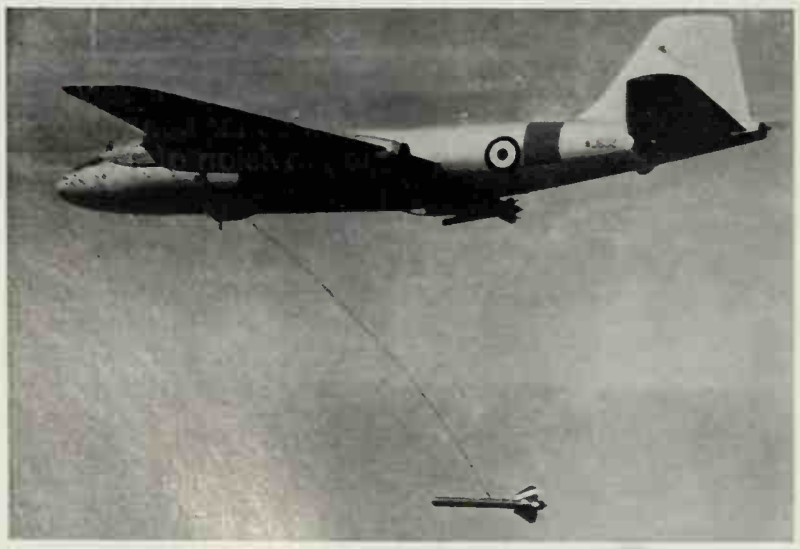
FR Rushton/Hayes target and winch pack fitted to RAF Canberra TT 18



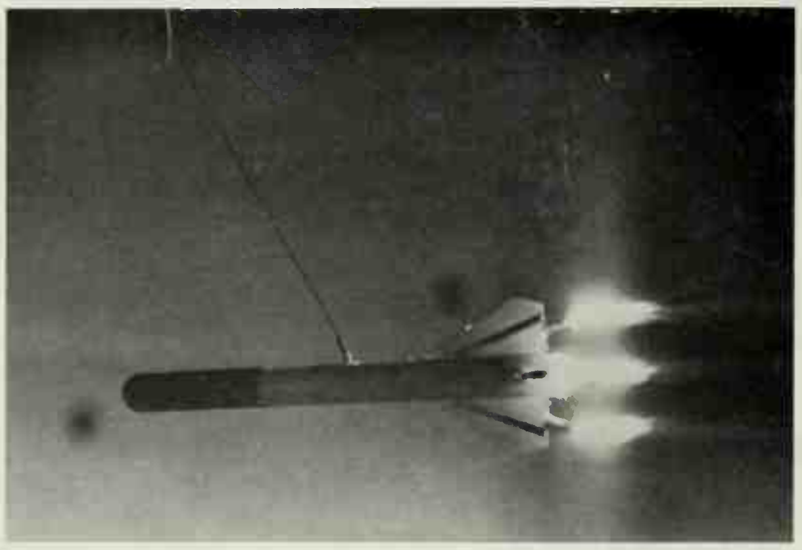
FR Rushton automatic long-tow winch with twin high-speed sleeve target dispenser and exchanger unit enables Canberra TT18 to provide a target for small arms firing practice



Three types of target on servicing trolley. Sectioned unit shows miss distance indicator, flares and parachute canister



FR Rushton/Hayes target being recovered on to launcher of FR Rushton winch



Four infra-red flares fired in salvo from FR Rushton/Hayes target

Target systems

for gunnery and missile training

Flight Refuelling Ltd is a leader in the design and manufacture of complete target systems.

Fifteen years ago, FR was selected by the British Government to develop the U15, U16 and U21 Meteor Drone pilotless aircraft to meet the firing practice demands of the Britsih armed forces for air-to-air and ground-to-air missile and gunnery training. Since then 240 of these aircraft have been delivered and they are still in production.

FR Rushton and Hayes targets

In 1963, FR acquired the right to manufacture under licence the Hayes TA7, which continues to be the standard towed target of the US Navy, US Air Force and US Marines. From it, FR developed the FR Rushton target system re-engineered to the requirements of the British Services and to incorporate fully automatic tow reels with tow lengths of up to 18 200m (60 000ft).

The standard system consists of winch, launcher, tow wire, radio command link and the targets. It is most versatile, ranging in character from a simple practice towed target to a sophisticated weapons testing unit, complete with flare firing, command radio circuit, braking parachute and Luneberg lenses to provide maximum radar reflectivity. The miss distance indicator (acoustic or scintillating) gives immediate read-out either in the towing aircraft or on the ground. Different types of flare provide the source for infra-red and light or smoke for visual tracking. Up to eight flares can be mounted for selective firing in singles, multiples or salvo, to gain maximum firing practice time per sortie.

FR Rushton winches

The winch is powered by a three-bladed ram-air turbine. The winch pack can be supplied with its own retractable launcher or with a fairlead used in conjunction with a separate pylon launcher. A single switch controls the whole operation from the time the target is deployed until it is retracted into the launcher.

Pay-out and wind-in speeds of up to 1050m (3500ft) per minute are achieved. The standard winch drum can hold enough cable for towing the target at distances of up to 18 200m (60 000ft) or about 18km (11½ miles) behind the towing aircraft. For tow lengths of over 6000m (20 000ft), stepped cables are used.

The capstan design enables maximum cable tension on the drum to be limited to 35kg (77lb), so that risk of cable damage due to untidy layering is avoided. Service life of tow lines is thus greatly enhanced.

The winch can deploy the Rushton target between sea level and 15 000m (50 000ft) at speeds ranging from 180 knots to Mach 1·7, dependent on altitude and length of tow.

Another important feature of the Rushton winch is that, without alteration, it can also accommodate a pack containing two standard sleeve targets. The entire range of target practice requirements can accordingly be met.

Applications

The standard FR Rushton target system, including winch and targets, has been specifically developed for firing on by the following weapons:

Air-to-air guided weapons: Firestreak
Red Top
Sidewinder 1A and IC
Sparrow AIM 7 E

Surface-to-air guided weapons: Rapier
Seacat
Sea Dart
Seaslug
Tigercat

Air-to-air unguided rockets: small calibre

Anti-aircraft gunnery systems: all calibres from 20mm upwards

Versatility

The FR Rushton and Hayes targets are currently in service with the following aircraft:

Canberra TT 18
Meteor TT 20
BQM34 Ryan/Firebee
F4 Phantom
F8U Crusader
F100 Super Sabre
F101 Voodoo

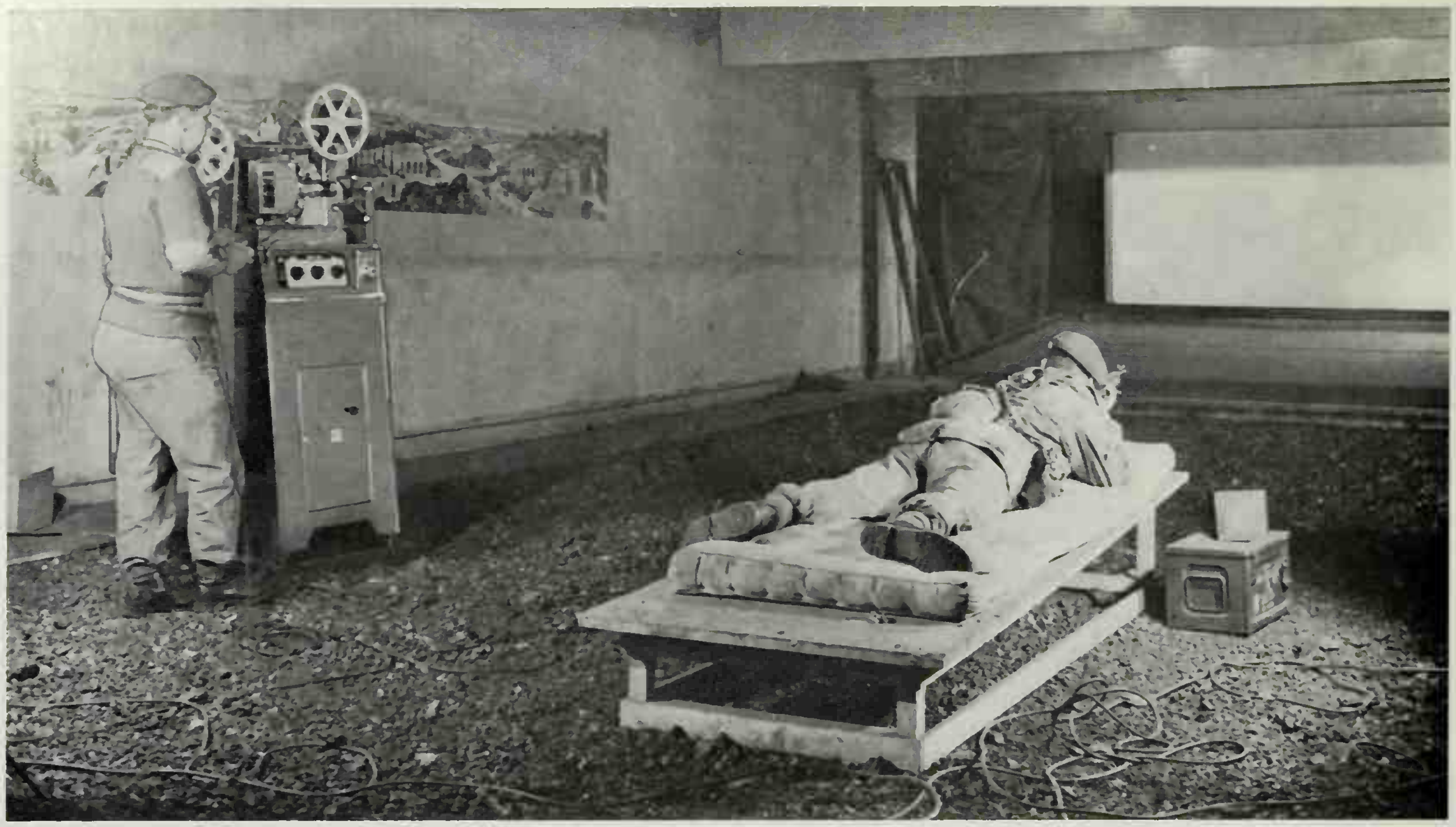
Design studies have been completed for the system to be attached to the following aircraft types:

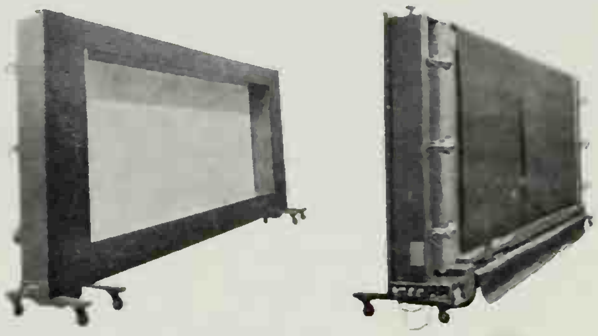
Buccaneer
Gannet
Lightning
Macchi MB 326
Mirage III
N. American Bronco OV 10
SAAB 105 XT
Sabre F 86
Sea Hawk
Starfighter F 104
Venom

Flight Refuelling target systems, as well as other FR products, have been evaluated, tested and selected for use by the Royal Navy, the Royal Air Force, the US Navy, the US Air Force, the US Marines and Aeronavale Française. Full technical and operational details of target systems and components are available.

FLIGHT REFUELLING LIMITED
Wimborne, Dorset, BH21 2BJ, England
Telephone: Wimborne 2121 Cables: Refuelling Wimborne Telex: 41247

FR



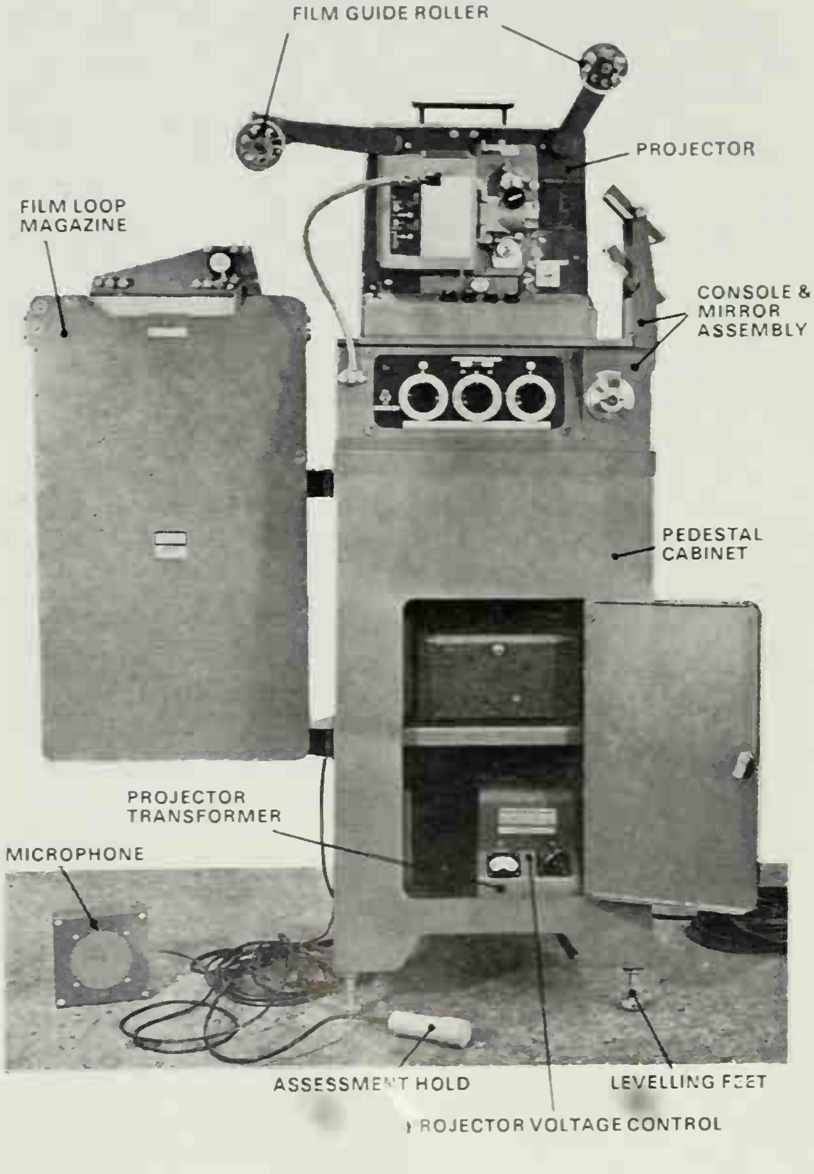


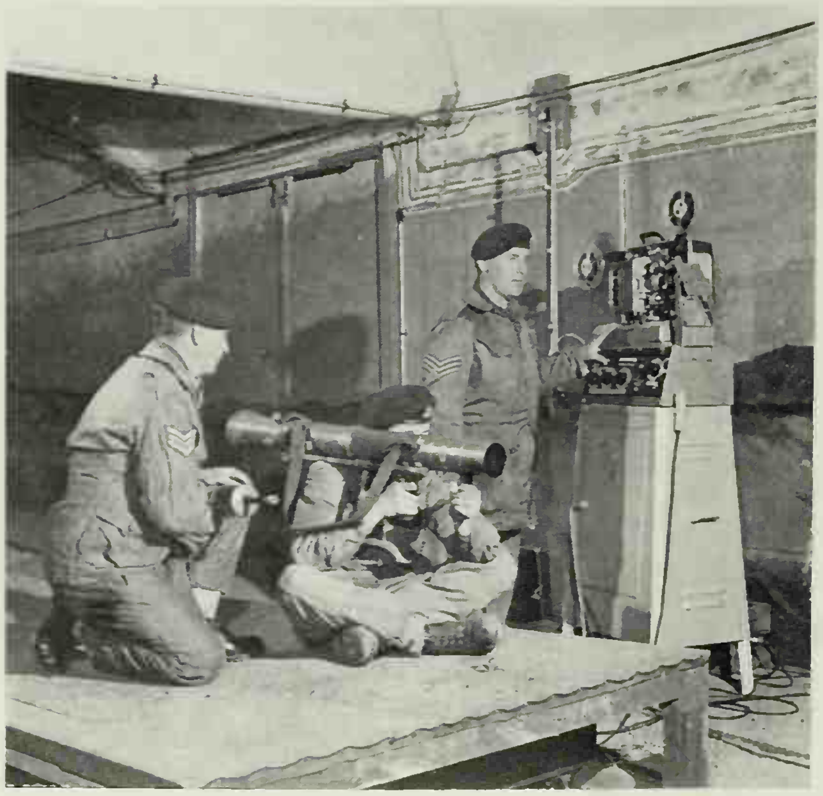
Screen front view (left) and rear view (right) showing floodlights, paper and drive

The CTTE can be installed in a standard indoor range provided that certain modifications are followed in accordance with safety requirements. In many cases, indoor ranges may already incorporate side and roof baffles to prevent ricochet, but additional features are necessary to present the equipment in the most advantageous form. The range should be a minimum of 6m (20ft) wide by 15m (50ft) long. In those indoor ranges where firing exercises are such that a bullet absorber is not already incorporated, it is necessary to install such an arrangement at the end of the range.

Around the perimeter of the screen is attached fabric masking which is designed to prevent any scattered light from the flood lamps of the screen unit from being deflected towards the firing point, and thus reducing the intensity of the picture projected.

The firing point for small arms weapons is usually 10m (33ft) from the screen unit. Anti-tank weapons can be fired from this point or, if mounted on wheels, alongside the platform. Wall baffling is required to catch stray bullets outside the target area of the screen.


FILM GUIDE ROLLER
PROJECTOR
FILM LOOP MAGAZINE
CONSOLE & MIRROR ASSEMBLY
PEDESTAL CABINET
PROJECTOR TRANSFORMER
MICROPHONE
ASSESSMENT HOLD
LEVELLING FEET
PROJECTOR VOLTAGE CONTROL



Ciné target range

for infantry training

RFD Cine Target Training Equipment

With the ever-present demand for the training of troops in a modern army to maintain a condition of preparedness at all times, the question of costs and battle training areas becomes a continual problem. A substitute for field exercises is therefore necessary to enable troops in training to experience the environmental conditions of combat situations.

Such a substitute should aim at providing realistic training in combat techniques over a wide field of defensive and offensive roles. The latest development in weapon training equipment produced by RFD-GQ is the Ciné Target Training Equipment (CTTE) which has been designed to provide indoor range training for small arms and anti-tank weapons. Developed in conjunction with the Small Arms Wing of the School of Infantry, the equipment provides a means of presenting moving targets in field conditions. This is achieved by a programme of films starting with basic techniques and ending with advanced marksmanship. Some advantages of this system of training are:

(*a*) the ability to train personnel in firing at a moving target,

(*b*) a considerable saving in costs can be achieved by the use of sub-calibre ammunition if required,

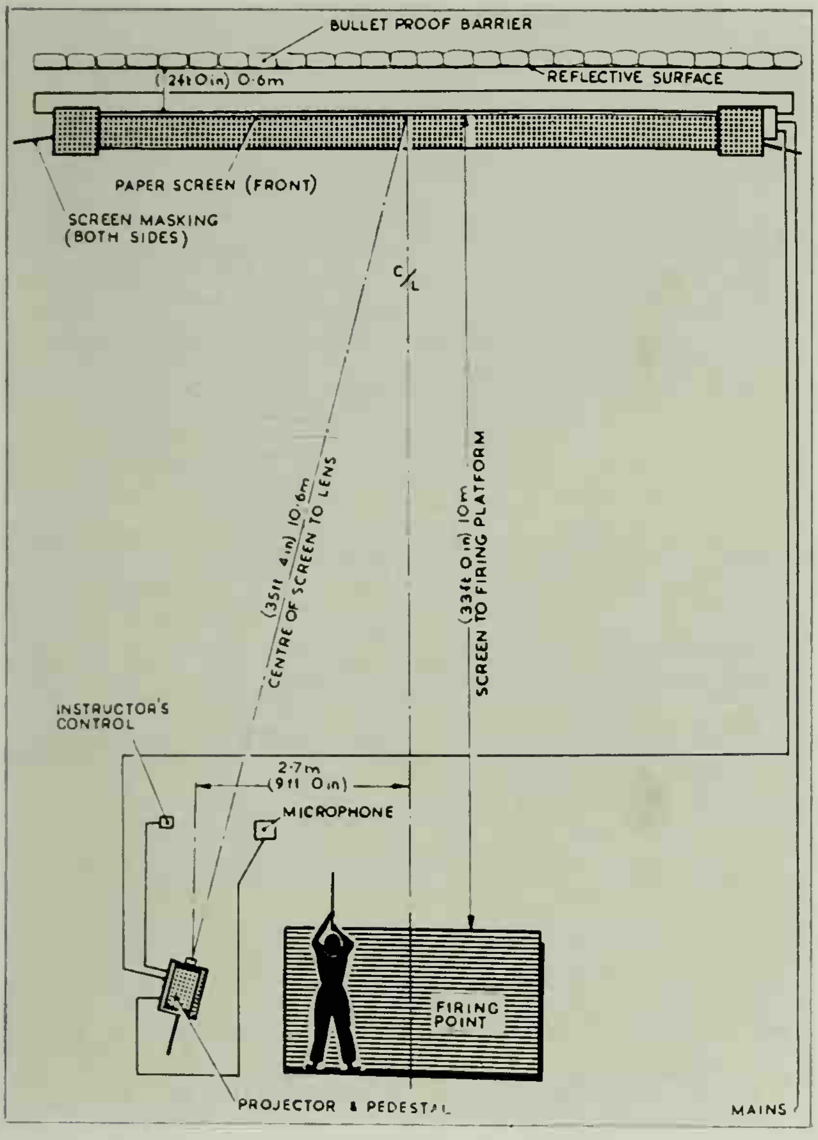
(*c*) high-velocity ammunition up to 9 mm calibre can be used,

(*d*) the equipment allows training to be carried out through a 24-hour period, irrespective of weather conditions or the availability of manpower and equipment,

(*e*) once the training programme has been filmed, it is available indefinitely either in a continuous loop or spool form.

With the CTTE, filmed sequences of actual battle conditions likely to be experienced are exhibited to the personnel under training and the targets displayed, infantry and/or armoured vehicles, are presented in the correct tactical form and size for the given range. Defensive or offensive exercises can therefore be depicted on film under a variety of territorial conditions.

When the CTTE is used for training with anti-tank weapons, sub-calibre devices can be fired instead of full calibre practice rounds. By this means, gun crews are also able to carry out normal field manning and maintain the 'feel' of the weapon.



Specification

Screen unit

Measures 5·65m × 2·26m (18ft 6in × 7ft 2in) and provides a screen area of 4·27m × 1·52m (14ft × 5ft). Bullet-proof protection consists of 25mm (1in) ply and 3mm (⅛in) mild steel plate. Eight castors, mounted under the end units, give mobility

Paper screen lateral movement: 2 rolls special Duplex fine-grain papers, white on blue. 45m (50yd) rolls, 1·8m (6ft) wide

Vertical movement: 3 rolls black paper comprising two 1·8m (6ft) and one 0·9m (3ft), all 45m (50yd) rolls.

Paper drives: fractional hp motors and dc electro-mechanical clutch systems

Paper travel recording: electro-mechanical with calibration chart for lateral movement of paper, showing reserve

Shot hole illumination: six floodlamps, 150W each, at rear of screen

Power supply for screen: single-phase, 240V, 50Hz, 15A

Projector

16mm portable projector with automatic quick-stop for holding single frames. Lens, standard 50mm (2in) with anamorphic lens attachment. Lamp, 115V, 1200W output. Operational hour meter recorder

Console

An electronic unit which carries mirror attachment, solenoid-operated, with control for simulating trajectory angle up to 4 deg 42min; flight time delay system of 0–3·99sec in steps of 0·01sec. Automatic stop control for projector. Microphone (acoustic detector) to activate stop mechanism sequence. Plugs, sockets, etc. for electrics are on rear panel. Separate power supply required, single-phase, 240V, 50Hz, 15A

Assessment time control

Automatic at 4sec with re-start and overriding manual hold switch

Pedestal unit

A metal-framed cabinet to carry console and projector. Levelling feet give correct alignment of picture on screen. Also fitted with mounting brackets to hold the film loop magazine

RFD-GQ LIMITED
Godalming, Surrey, England
Telephone: Godalming 4122   Cables: Airships Godalming   Telex: 85233

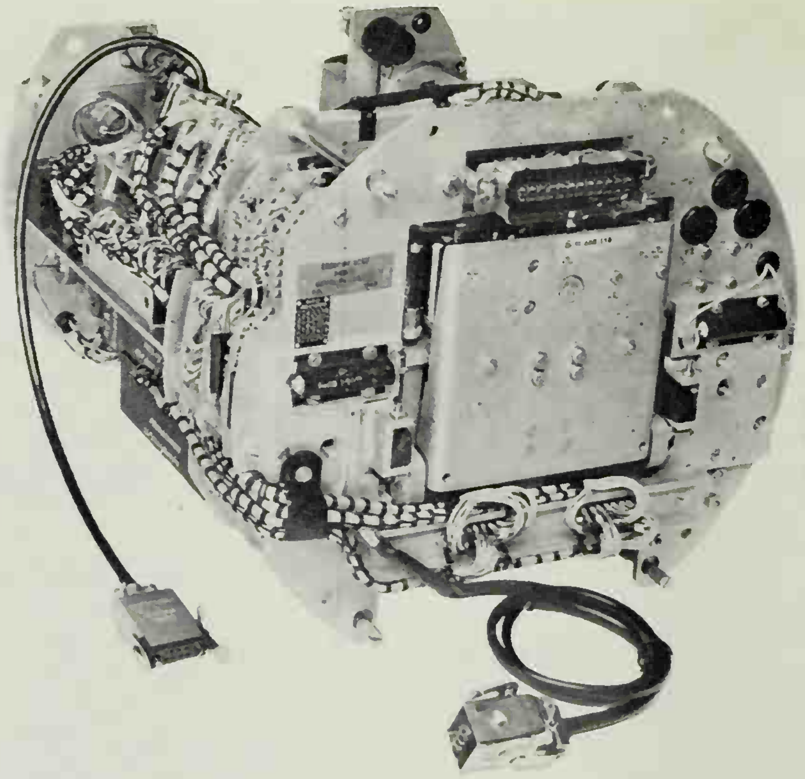
Torpedo exercise head

The casing of the torpedo exercise head UK Mk 1 for British lightweight torpedoes houses an electronics chassis mounting various transducers and electronic equipment, together with an RDL Series 600 magnetic tape system and battery power supply. Nineteen channels of data in both FM and digital form are recorded.

A pressure manifold is attached to the casing and mounts three pressure switches and a depth-sensing, pressure-actuated potentiometer. A squib-released, spring-ejected lead dump is housed within the casing. On release of the lead dump, positive buoyancy returns the torpedo to the surface. Once surfaced, a beeper unit generates signals which aid in locating the torpedo.

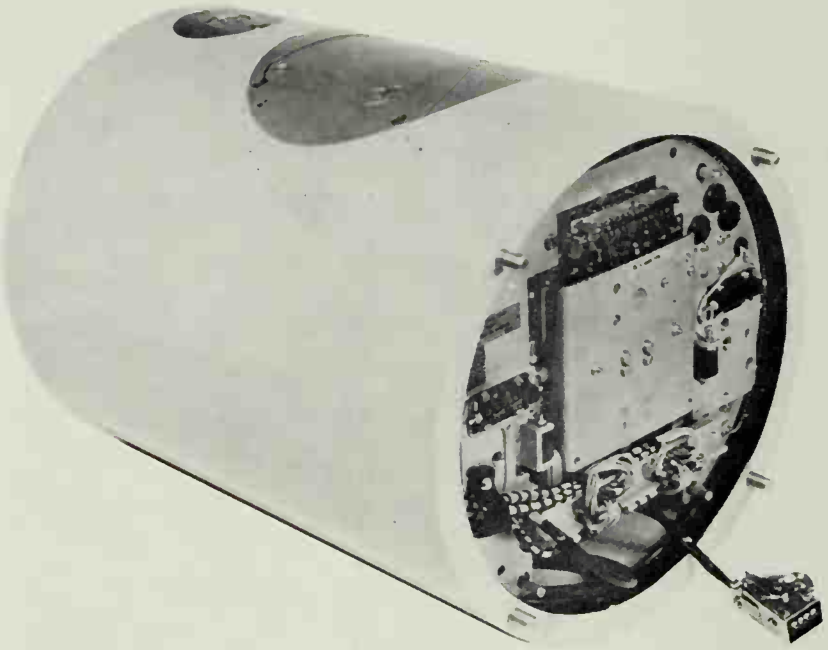
Programmed relay logic initiates action which ensures recovery in the event of critical malfunctioning, as well as after a satisfactory run.

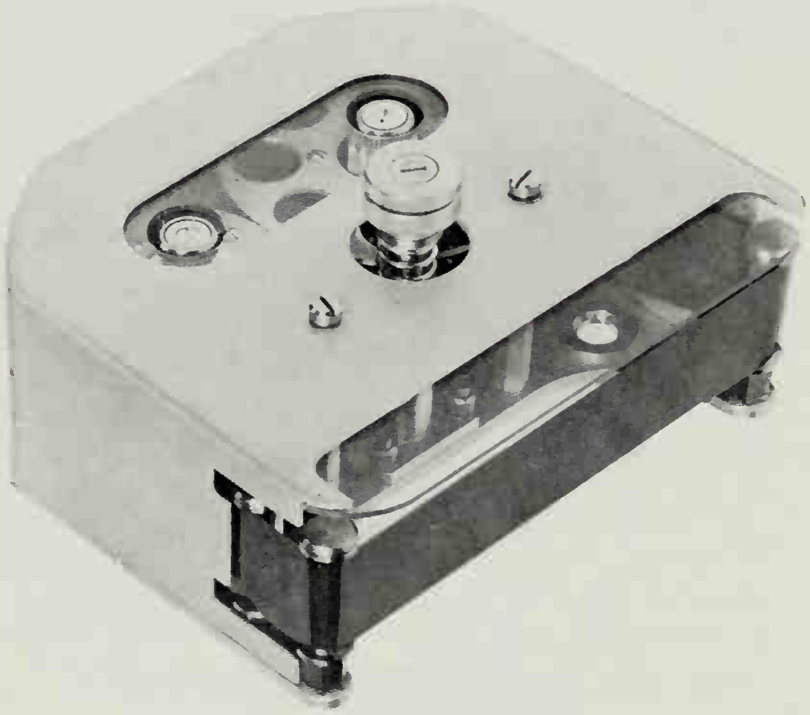
A comprehensive calibration/replay system provides all power supplies required by the torpedo head, together with signal sources simulating parameters prevailing in the torpedo afterbody under operational conditions.



Above: Electronics chassis of torpedo exercise head UK Mk 1. It is self-contained and connected by means of unitors

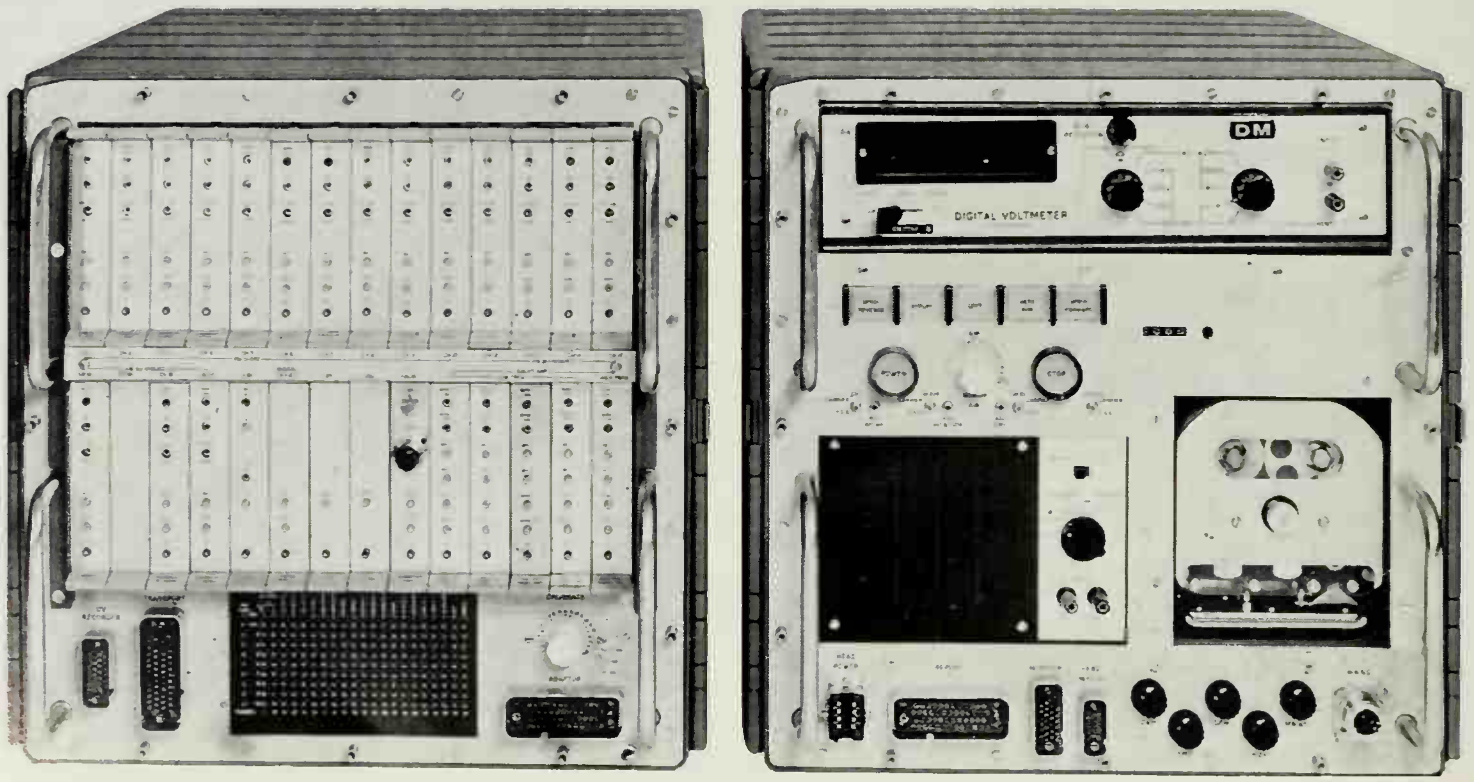
Below: Head casing of torpedo head with electronics chassis in situ, ready for mounting





Top: Tape cassette (greatly enlarged) for use in RDL Series 600 recording system. The cassette can be inserted and removed through the beeper aperture in the head casing

Below: Calibration/replay analysis equipment



Deep mobile target

Underwater free-running vehicle

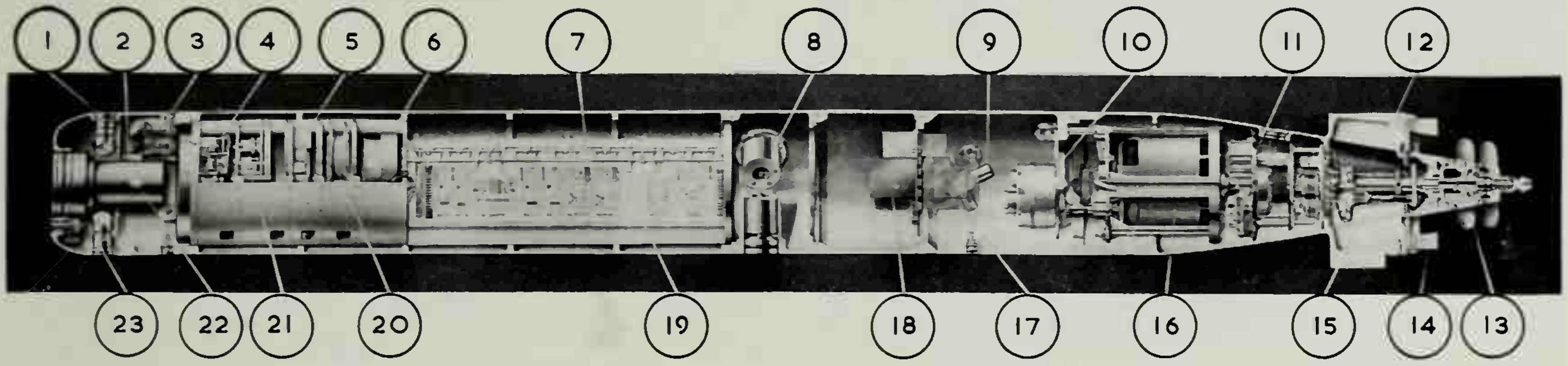
The Deep Mobile Target (DMT) is being developed by Recording Designs Limited for the British Ministry of Defence in collaboration with the Admiralty Underwater Weapons Establishment at Portland, Dorset, England. It may be used for the evaluation of torpedoes in both active and passive modes, and for the vital task of aiding the sonar training of personnel and the evaluation of sonar equipment.

The target is fully instrumented and entirely self-contained with the capability of simulating the dynamic and acoustic characteristics of current submarines. The main purpose of the mobile target, therefore, is to play the role of a target submarine without the cost and hazards involved in using a submarine for this service.

Consideration was given during the development of the DMT to meet the future requirement of a fleet target and in consequence it is being designed and engineered to full inter-service standards. Reliability and maintainability have been factors of prime importance in its development and its flexibility has been greatly enhanced by the facilities which are being built into the mobile target, such as the future needs of new torpedo homing frequencies or different sonar frequency outputs.

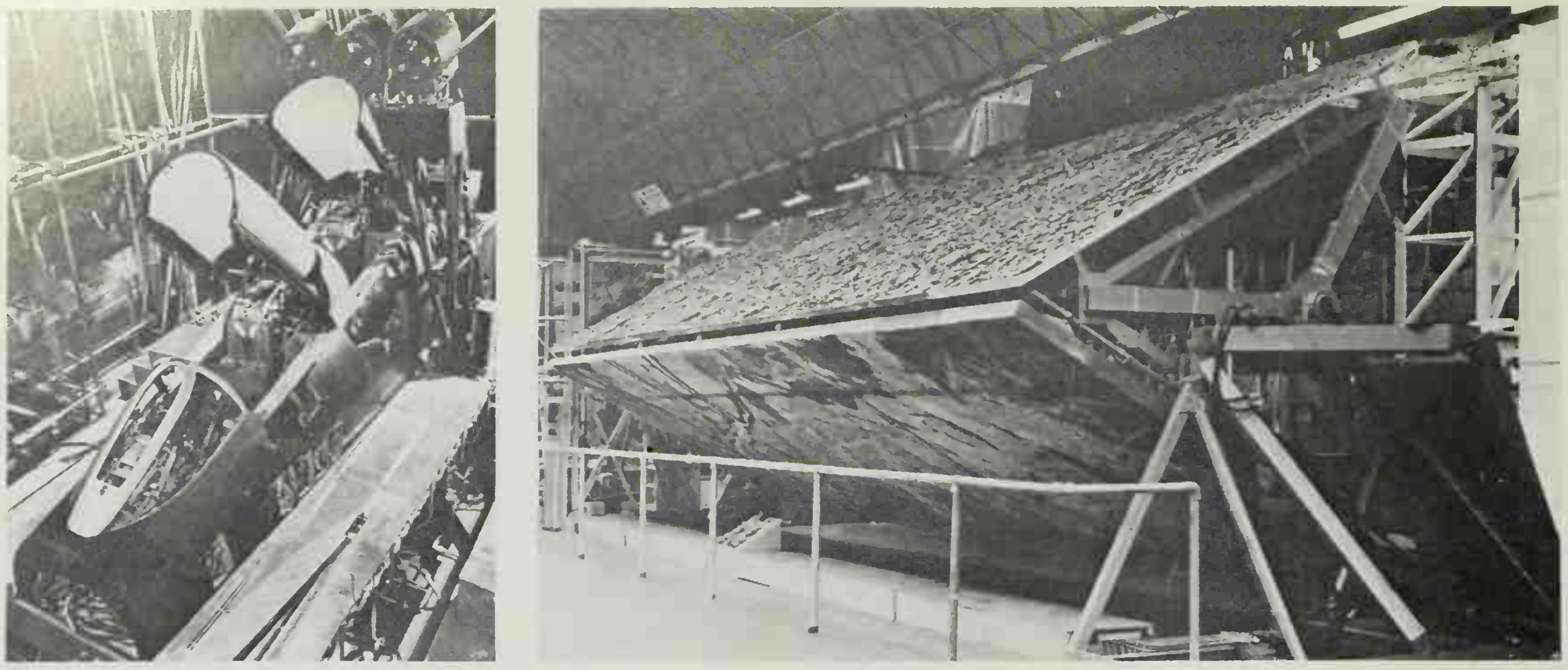
One of the most important facilities in the DMT is the miss distance indicator system which enables the final weapon attack phase of approximately 106 m (350 ft) to be computed and recorded within the vehicle itself, thus aiding torpedo proofing and evaluation trials.

A system, called the torpedo information processor, has been developed by Recording Designs Limited for reducing/computing and displaying visually all the information recorded on the magnetic tape recorder within the deep mobile target.

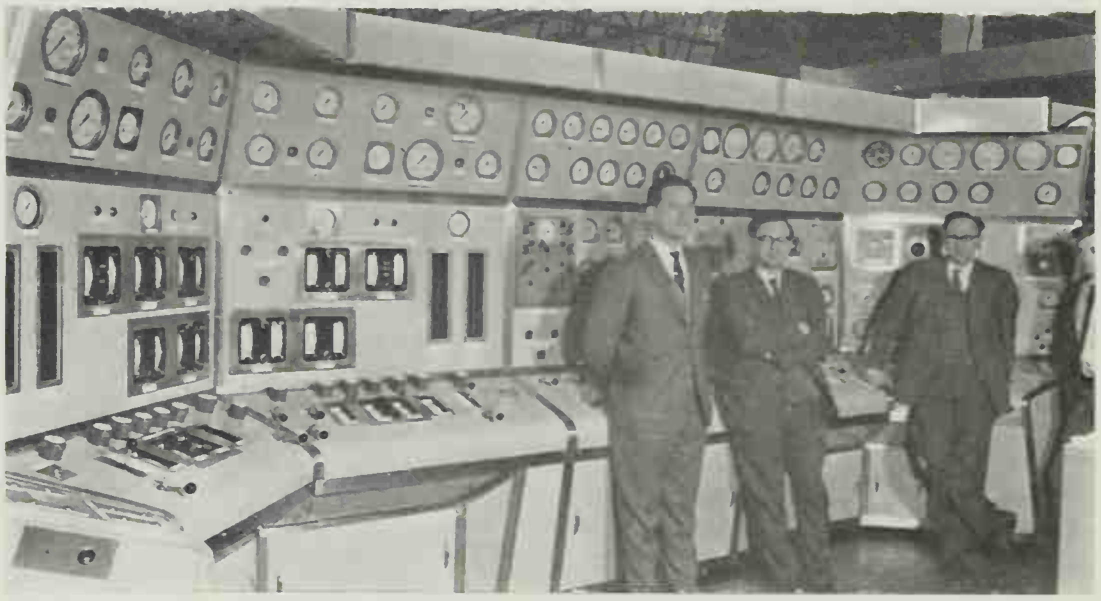


1 SAT transducers
2 Flux gates
3 Echo repeat transducers
4 Magnetic tape recorder
5 Echo repeat
6 Synchronised acoustic transmitter (SAT)
7 Battery (silver zinc 4 × 30 V)
8 Sonar transducers
9 Pressure switches
10 Speed-change switch
11 Steering electronics (power stages)
12 Steering controls
13 Propellers
14 Rudder
15 Concentric propeller shafts
16 Contra-rotating motor
17 Beeper
18 Pendulum unit and accelerometer
19 Control system electronics
20 Miss-distance indicator (MDI)
21 Programmer
22 MDI transducers
23 Lead dump

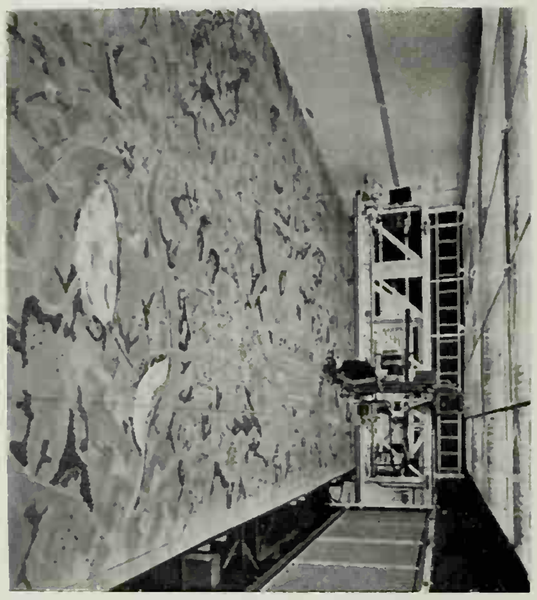
RECORDING DESIGNS LIMITED
Blackwater Station Estate, Blackwater, Camberley, Surrey, England
Telephone: Camberley 24622 Telex: 85272



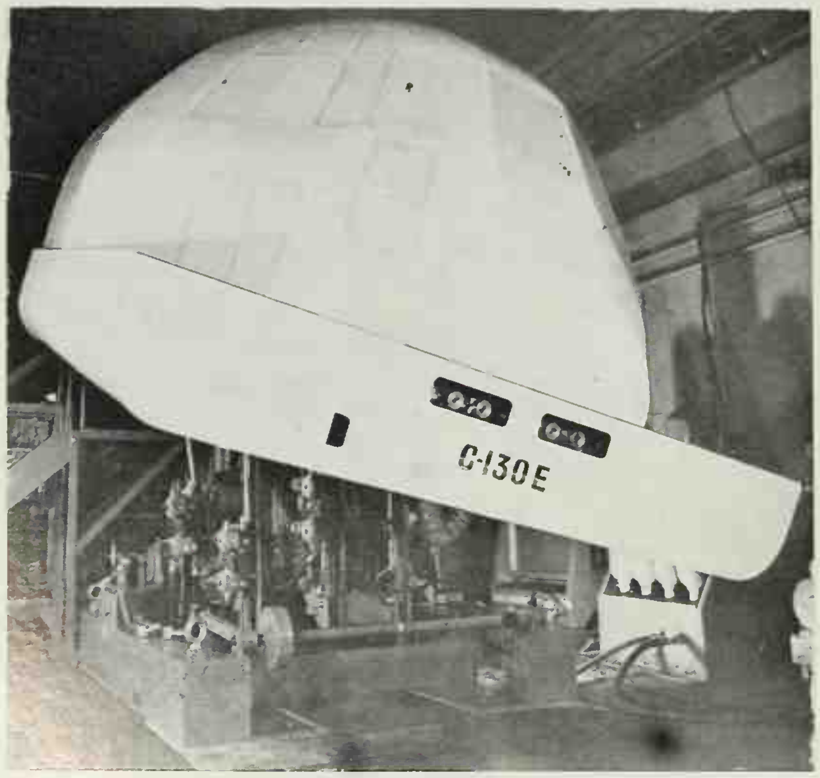
This Phantom flight simulator is one of the most sophisticated military flight simulators in the world. One has been ordered by the Royal Navy, four by the Royal Air Force. It is mounted on a three-axis motion system. The visual system includes a model of an airfield area, another of a weapon training area, and a third of an area for navigation exercises. This simulator also has a radar landmass attachment which permits realistic simulation of the mapping radar presentation in the navigator's cockpit

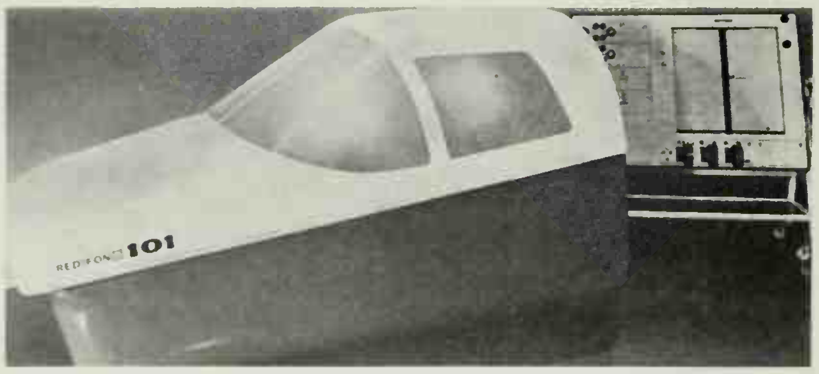


This simulator of a County Class destroyer main control room console has been used for training students on flashing up routines and general engine room management. Simulation covers fuel management, boiler control, steam raising and steam turbine control, both for port and starboard sections. Ancillaries such as bearing temperatures, electrical supplies and engine telegraphs are also simulated



Rigid Model visual flight system, showing terrain and camera gantry





Above: Redifon 101 instrument flight trainer

Left: this Lockheed C-130E flight simulator is a fully digital flight simulator mounted on a three-axis motion system and is installed at a RAAF base in NSW, Australia. It is used for training flight crews in all normal and emergency procedures. A novel feature is the simulation of an electrical fault whereby the flight deck is completely filled with smoke. The equipment was flown in two RAAF C-130 aircraft to Australia and was fully operational within eight weeks of shipment from the factory in England

Flight simulators

and trainers of all types

The economic and practical operational pressures resulting from the use of large subsonic and supersonic aircraft has transformed the flight simulator into a primary rather than a secondary training aid.

The need to regard the flight simulator as an essential part of flying training instead of a useful adjunct has necessitated a considerable extension to the scope of simulation, its accuracy and realism. The introduction of digital techniques, high-performance multi-axis motion systems, the Redifon visual flight system has permitted the flight simulator to meet a constant growth of diverse requirements.

Redifon, the largest manufacturer of flight simulators in Europe and second in the world, as well as being the established leader in the rapidly expanding field of visual flight simulation, has supplied some 200 flight simulators throughout the world, of which nearly half are for military aircraft. Some examples are listed below:

Military simulators—United Kingdom

Aircraft type	Quantity
VC-10	1
HS Nimrod	4
Buccaneer	3
Phantom	5
Lightning Mk 1	1
Lightning Mk 2	2
Lightning Mk 3	8
Comet 2	1
Comet 4	1
Argosy	2
Meteor	1
Hunter	4
Javelin	6
Gnat	3
Gannet	2
Scimitar	2
Wessex helicopter	1
Valiant	3
Vulcan	4
Victor	2
101 instrument flight trainer	1

Military simulators—Overseas

Aircraft type	Quantity
Buccaneer	1
Agusta Bell 204B helicopter	1
Lockheed C130	2
Canadair CC106	1
Transaal C160	1
CHSS-2 helicopter	1
Northrop F5	5
Aermacchi MB326	6
Lightning	3
Sabre	15
Canberra	1
Hunter	3
101 instrument flight trainer	8

Other simulators

Redifon manufactures digital and analogue flight simulators of all kinds, including type trainers and procedure trainers, as well as closed-circuit colour television visual systems, marine radar simulators, action speed tactical teachers and weapons trainers, ship's control room and submarine simulators, anti-submarine tactical simulators, vehicle-driving trainers, and other simulators for specialised purposes.

Computers

As an essential part of its simulators and trainers, Redifon also designs and manufactures its own digital and analogue computers and interface equipment, and computer-based data preparation systems. The Redifon 2000 general-purpose digital computer, as incorporated in both military and civil flight simulators, is a fast, high-performance machine designed for scientific and real-time applications.

The computer features a one-microsecond memory cycle, uses integrated circuits extensively and all semiconductors are silicon for reliability. It has a very powerful instruction repertoire including indexing and indirect addressing, hardware multiply and divide, flexible single-bit and half-length word operation. A software package is provided complete with assembler, diagnostics and utility programmes. Peripherals include an IBM Selectric typewriter, 300 characters per second paper-tape reader and a 110 characters per second paper-tape punch as standard equipment.

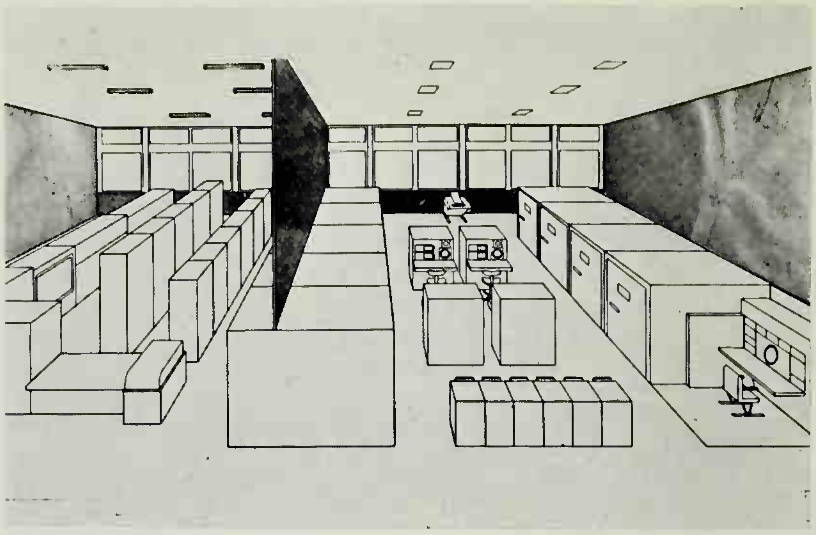
The Redifon 2000 digital computer which handles the data processing in many Redifon simulators and trainers

REDIFON LIMITED
Flight Simulation Marketing Unit
Broomhill Road, London SW 18, England
Telephone: 01-874 7281 Telex: 264029

REDIFON

1966
1970

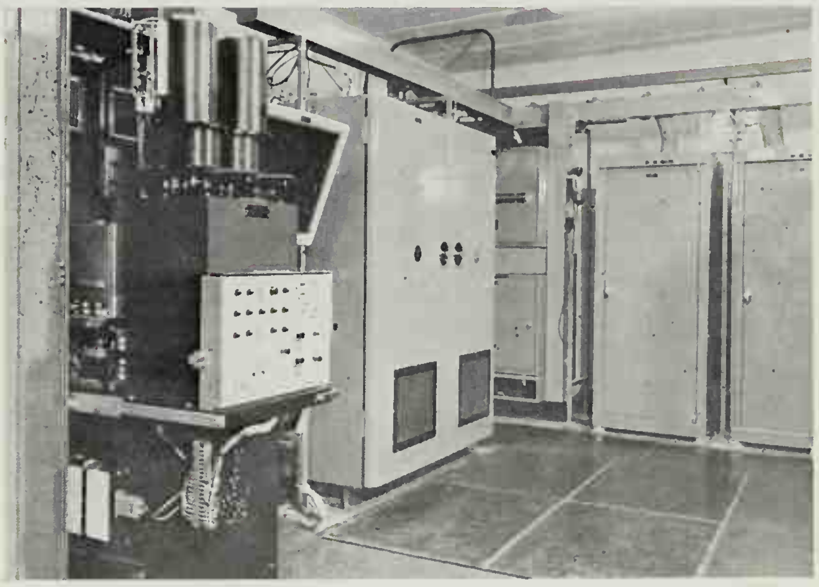
An instructor and a group of students at the Royal Air Force Central Air Traffic Control School, working together on a Solartron basic trainer simulating precision approach radar (PAR)

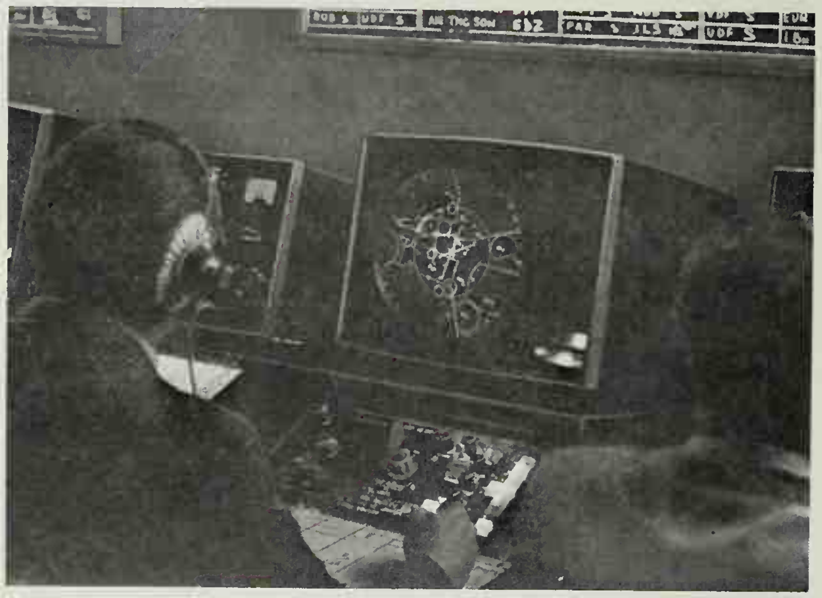


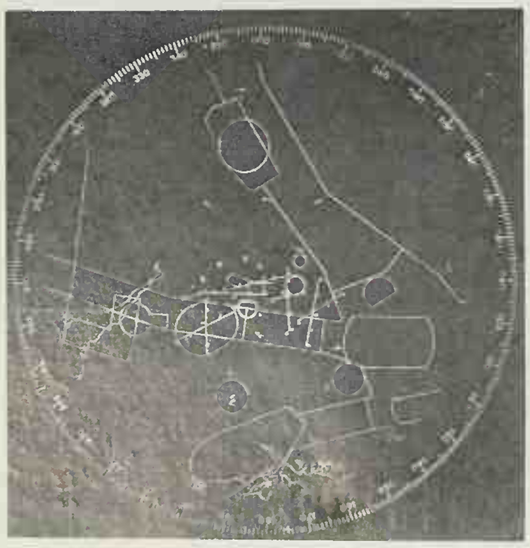
Diagrammatic representation of an air electronics trainer (a flight simulator for training air electronics officers), suitable for elementary and advanced instruction in electrical systems, communications, radar and ECM

A student from the Women's Royal Air Force (WRAF) acting as final approach controller, on a Solartron air traffic control simulator, adjusting the elevation servo for the PAR. A simulated aircraft is shown at about four miles from touchdown

Student in one of the life-like cubicles of the air electronics trainer





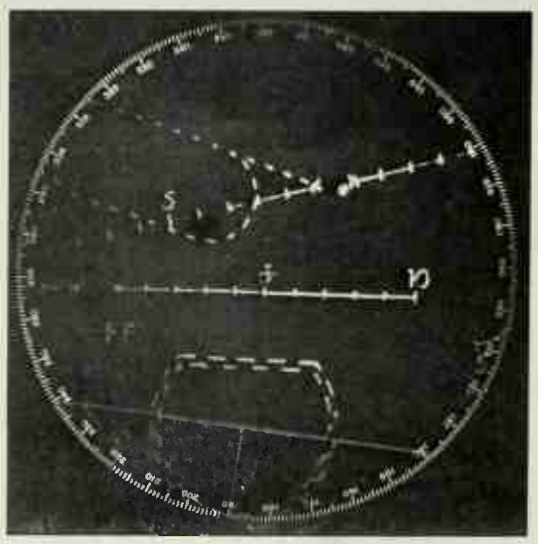


Above left: Solartron SY2046 high-resolution video map at RAF station Benson, with optical system withdrawn to show twin optical channels allowing choice between two map plates at each display position

Above right: approach control room at RAF station Benson. The display range setting is 30nm.

Left: video map at displayed range of 75nm

Right: centre of same map at displayed range of 7½nm



Simulators and video maps

for air traffic control and defence

Solartron air traffic control simulators

In the field of ground-to-air simulation equipment, Solartron has paid particular attention to the needs of air traffic control training, in both the military and civil spheres. The latest comprehensive range of equipments cover both radar and non-radar aspects.

Although Solartron simulators comprise a wide variety of types for diverse applications, they are designed mainly to provide, on radar or other display equipment, a synthetic version of the appropriate data. These may include, for example, radar echoes from fully controllable aircraft or other targets, permanent echoes from geographical features, weather effects and operational and control data.

Operationally, the purpose of these equipments is to provide a synthetic but essentially realistic means of training and evaluation for radar operators, operational teams, controllers and other key personnel.

The pictures opposite show some of the 13 Solartron simulators in use at the RAF Central Air Traffic Control School, Shawbury. Each of the advanced trainers at the school is designed to simulate fully the approach control environment with both surveillance radar and precision approach radar (PAR). Commutated aerial direction finding (CADF) and secondary surveillance radar (SSR) simulators are also included.

Solartron special flight trainers

In the air electronics trainer (a flight simulator for air electronics officers) ten students, each seated in a separate cubicle representing the air electronics cabin in an aircraft, receive elementary and advanced training in the operation of electrical systems, communications, radar and electronic counter measures equipment.

An exercise would cover aircraft preparation procedures, engine starting, pre-flight checks, and take-off. During the following airborne phase a realistic radar picture of the area below, ECM, communications and electrical systems simulation are provided, with a programme of pre-computed equipment failures.

Four instructors guide the students through the exercise and act as pilots when required.

Solartron ground control interception simulators

Radar simulators in the defence field cover the full range of operation from early warning to fighter recovery. Student controllers and trackers work with radar displays similar to those used operationally, backed by marking and handover facilities. Simulation of stacked-beam and height-finder radars can be provided together with the effects of electronic counter-measures (ECM) and electronic counter-counter measures (ECCM).

In larger systems using digital techniques it is possible to provide considerable numbers of pre-programmed targets and to preserve a precise record of each exercise. In the smaller digital simulators video tape recording is used both to supplement the threat and to record results.

The same video mapping, permanent echo and weather generation facilities are available for GCI simulators as for ATC equipments.

Solartron high-resolution video maps

A video map is a means of displaying topographical and other static information in relation to a radar picture. Its operational usefulness depends on the extent to which detail can be displayed (resolution) and the ability to maintain a precise relationship between radar and video map pictures (accuracy).

The Solartron high-resolution video map achieves a standard of resolution and accuracy which permits an entirely new approach to the operational use of video maps.

The two reproductions of a plan position indicator (PPI) display at the bottom of the opposite page show clearly the amount of information which can be included on the video map plate without taxing the resolution of the equipment. Both show the same plate, but the one at the right shows a central portion only at a magnification of ×10. Typical accuracy in relation to an extended runway centre-line at six miles from touchdown is better than 50m (150ft) left or right.

These high-resolution video maps have been responsible for a quiet revolution in the techniques of radar control in which range and bearing data have been largely superseded by positional references. In air traffic control they contribute to air safety by significantly reducing the risks of accidental penetration of controlled airspace.

All Royal Air Force stations included in the current ATC radar equipment programme have Solartron high-resolution video maps.

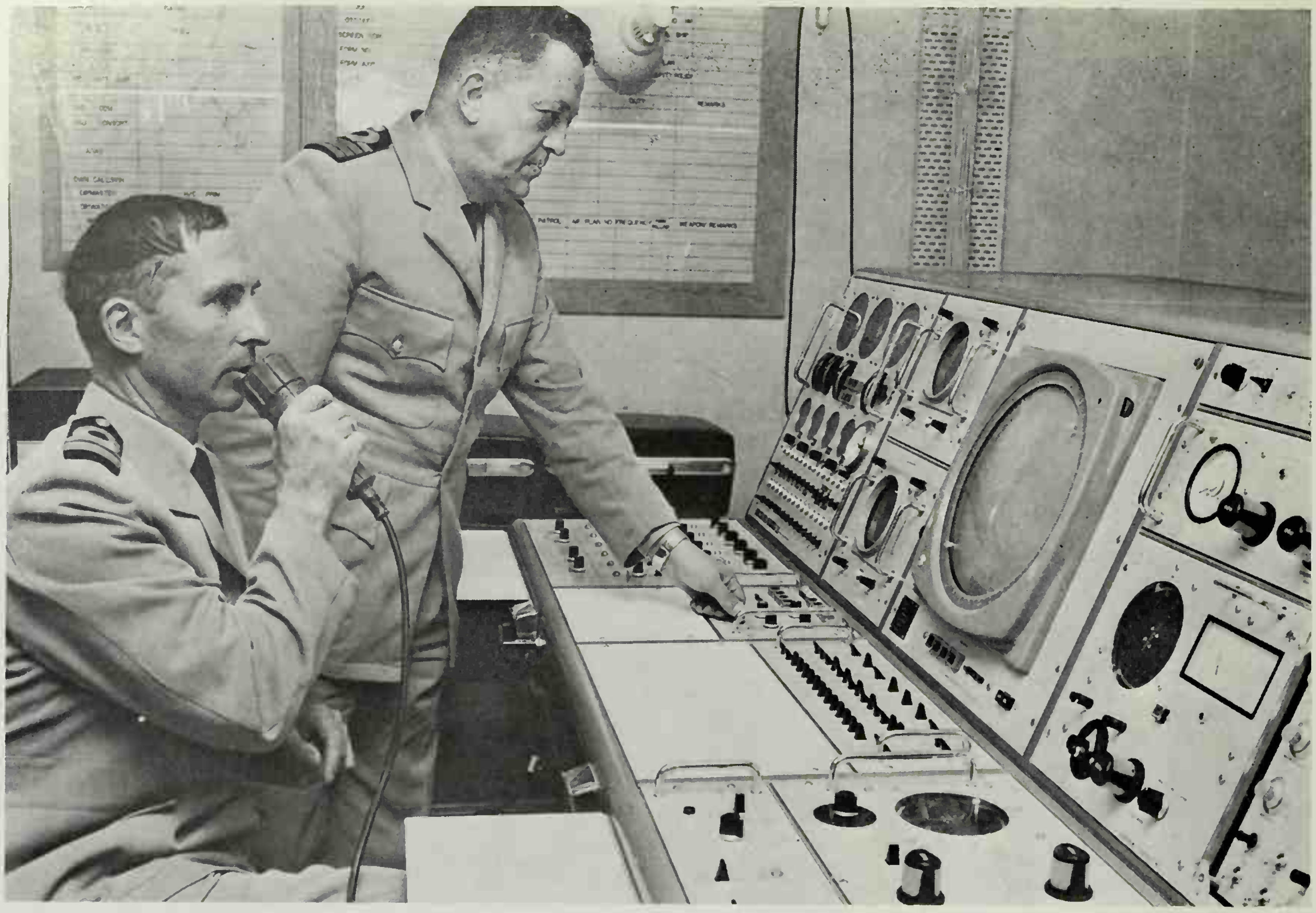
Single and dual-optic video map equipments are available in double or single-bay configurations. A smaller, more compact version, designed to permit transportation and operation from a road trailer, is also available.

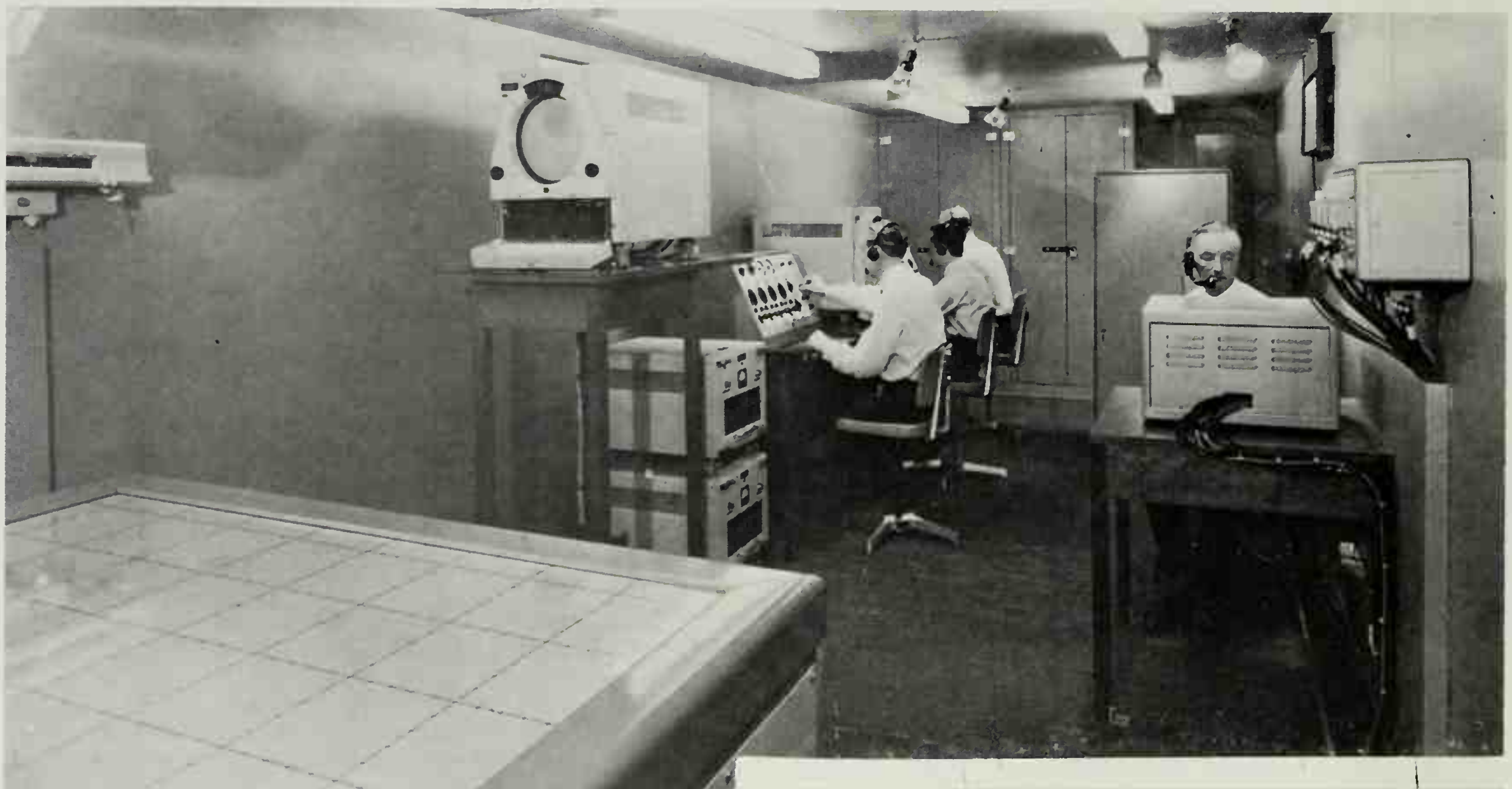
Video maps are now available in a transportable version designed for trailer-mounting as part of a mobile radar installation. They can operate without change of plate in an area having a radius equal to half the operational range of the radar.

Solartron radar video tape recorders

Video tape recorders are supplied as separate items as well as forming part of simulator equipment. Using tape decks designed to TV Raster standards, they can record the video from a radar or a simulator together with a related audio channel.

THE SOLARTRON ELECTRONIC GROUP LIMITED
Farnborough, Hampshire, England
Telephone: Farnborough 44433 Cables: Solartron Farnborough Telex: 85245





Top: view of the control console of the Solartron sonar trainer supplied to the Royal Norwegian Navy (photo by courtesy of the editor of 'Vi Menn')

Above: interior of the mobile Solartron marine radar simulator, which is housed in the trailers shown in the inset (right)

Simulators and trainers

for naval and marine use

The Solartron Electronic Group manufacture a complete range of simulators and trainers for naval and marine use. These fall naturally into the following different types.

Operations trainer

This system uses digital computation and provides a number of radar-carrying ships, targets and a realistic coastline to those under training. Its main purpose is to train operators and plotters in their basic skills and to weld them into a complete operations room team. If there are sufficient radar-carrying ships and targets in this type of trainer, all can also be used for tactical training of the Command. Examples are the Redpole trainer shown here, with six radar-carrying ships and 30 targets, installed at HMS *Dryad,* and the £2m combined action information and tactical trainer ordered for the Royal Australian Navy.

Action speed tactical trainer

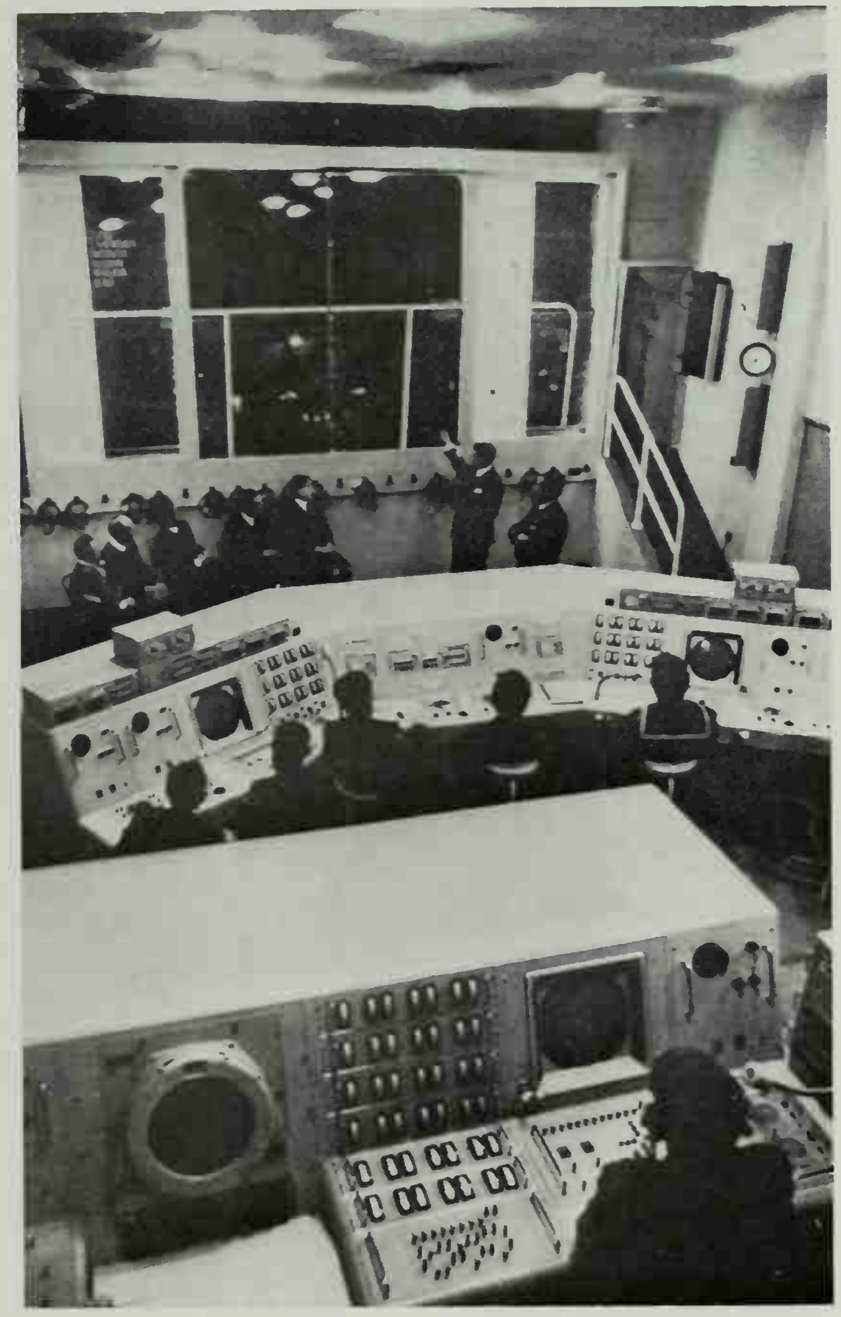
In its purest form the action speed tactical trainer is designed exclusively for training the Command in tactics. The designs are nowadays based entirely on digital techniques (although Solartron have installed advanced analogue systems). Two simulators of this type have been installed recently, one of them for the Turkish Navy.

Sonar and gunnery system trainers

At present it is still less expensive to use analogue computing methods for these types of trainer and, to obtain the accuracy required when there is a wide range ratio from many thousands down to a few hundred yards, servo-resolver techniques are employed. Solartron has supplied an advanced sonar system trainer to the Royal Norwegian Navy and gunnery system trainers to the Royal Swedish Navy. Of the latter, several are transportable so that they can be carried from ship to ship and connected to the ship's gunnery system for training in the operators' ship.

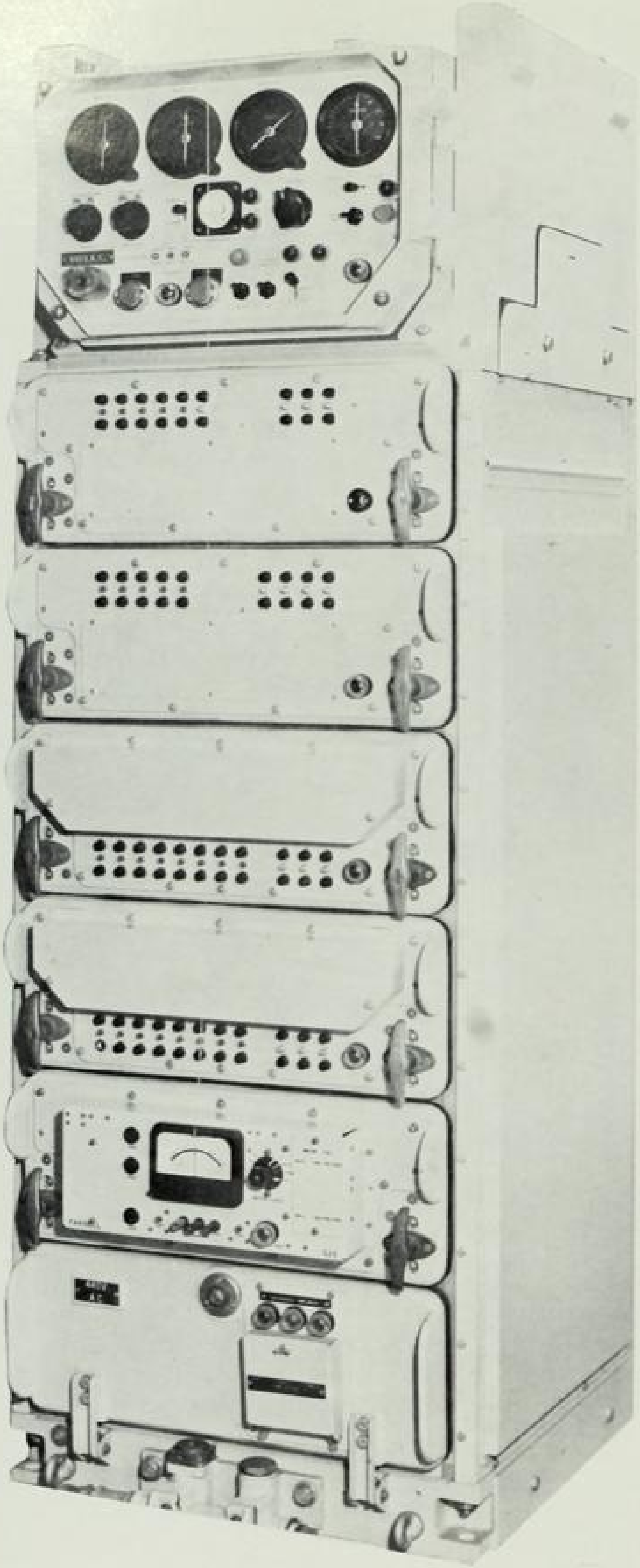
Marine radar simulator

This is a standard digital equipment to meet the British Ministry of Transport Specification for use in civilian navigation schools and is available in standard form with one, two or three radar-carrying ships, a number of targets and realistic coastline. It can be readily adapted for naval use by the inclusion of target speeds to cover the different ranges required by ships, helicopters and aircraft. A simulator of this type has been installed for the Royal Australian Navy and two have been supplied to the Royal Navy, each with one own ship and eight targets for helicopter direction training. These simulators have been built in trailers as shown opposite and can be easily moved to wherever the training is required, such as to a jetty alongside a ship.

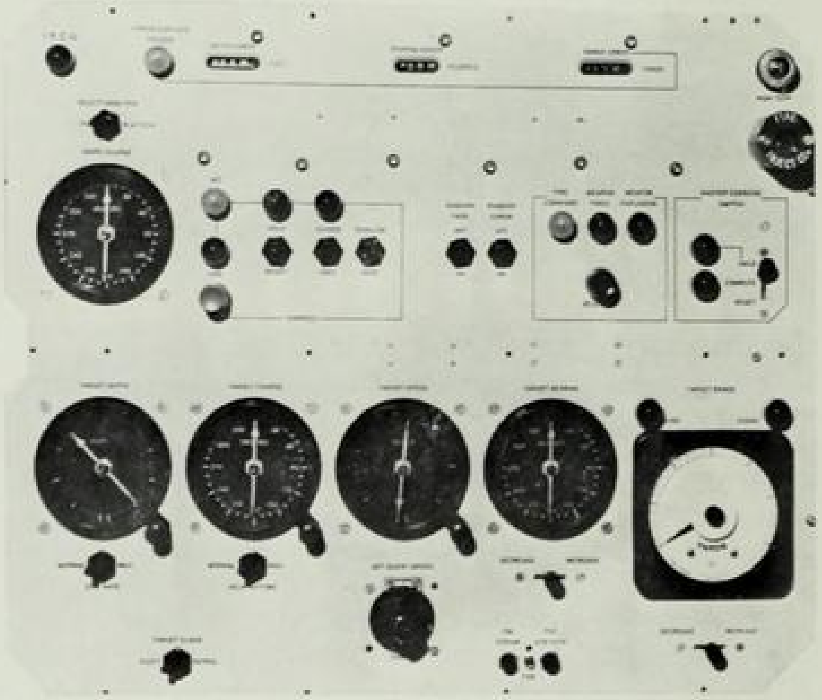


General view of 'Redpole' action speed tactical trainer installation, with provision for six radar-carrying ships and 30 targets

THE SOLARTRON ELECTRONIC GROUP LIMITED
Farnborough, Hampshire, England
Telephone: Farnborough 44433 Cables: Solartron Farnborough Telex: 85245

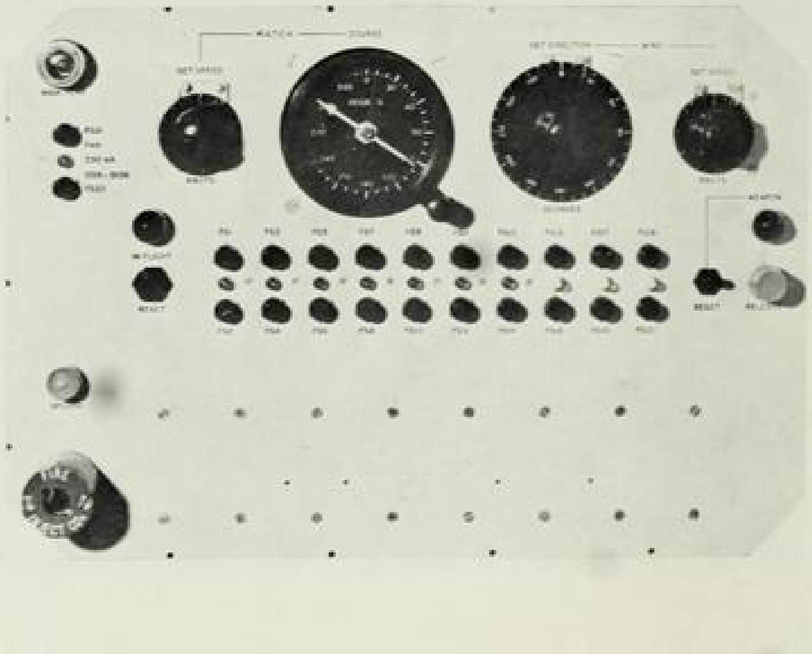


The main electronics cabinet of the Thorn Bendix shipborne anti-submarine simulator and command trainer. Housed in a standard waterproof rack, the cabinet can be located in any convenient position, depending on ship's layout



The instructor's remote control unit (above) is compact and can be located outside the operations room

The helicopter pilot's control panel (below) can also be remotely mounted, with the pilot receiving instructions from the operations room



Anti-submarine trainer

Shipborne simulator for command training

The purpose of the trainer is to provide exercises in anti-submarine warfare action for the whole command team of a ship at sea without a real target submarine being present and without actual launching of weapons.

The training covers the sonar attacks at long and short range and provides an automatic analysis of the results of such attacks.

The trainer consists of an analogue computer which simulates the movement of a submarine, a torpedo fired from the submarine and a helicopter. All ranges and bearings are relative to the surface ship which carries the trainer; inputs are also fed into the computer relating to its own speed and course.

The movements of the submarine, helicopter and torpedo are under the control of appropriate instructors and can be driven along required courses only in a realistic manner at pre-determined maximum speeds, turning and dive rates.

The computer generates the appropriate sonar echoes and hydrophone effect from the simulated submarine and torpedo in accordance with range, bearing, aspect and depth. Additional variable parameters such as sea state and layer depth can be selected directly by the instructor.

The sonar echoes and hydrophone effect are fed into the existing sonar sets on board the surface ship which are operating normally and in consequence are providing authentic background signals.

Separate control units are provided for the instructor and helicopter pilot. These control units may be positioned in the operations room away from the computer.

The instructor may also fire a torpedo at a selected speed, on a free or guided course at the ship. The helicopter pilot may attack the submarine and drop a weapon on it.

At the end of an exercise the computer can be frozen and a full analysis is available of the result. A co-ordinate plotter is also provided which gives an overall record of the courses of the submarine, torpedo and helicopter throughout the exercise.

Instructor's remote control unit

At the start of an exercise the instructor sets up the initial conditions, range, bearing and depth of the submarine at a predetermined range and bearing from the ship. This is normally effected from the main computer cabinet sited in the sonar control room. Thereafter the instructor controls the exercise from a remote position in the operations room.

When control is gained by the sonar operators, the command team is brought into the exercise and normal operations room procedures are carried out.

Helicopter simulator

The helicopter director officer is provided with a marker on his radar display which represents the helicopter and he can carry out an attack and drop a weapon on the target by means of his control unit.

When the range has reduced sufficiently the surface ship can also carry out a mortar attack and feed explosion data in the weapon analyser in the main computer.

The data can be frozen at explosion time and are presented to the instructor in terms of error relative to target position.

The instructor may also fire a torpedo on a free flight or guided course. Analysis of the result of the attack is available on the XY plotter.

Main features of the trainer

1) Provides maximum realism and the most effective training at the minimum cost.

2) Provides training for the whole command team of a ship at sea.

3) A complete exercise can be carried out without the need for live submarines, torpedoes or a helicopter.

4) The trainer is completely flexible and can be adapted to work with any sonar set.

5) Complete realism is achieved since the trainer is located on board ship and all background effects are genuine.

6) The trainer can simulate the most advanced submarine manoeuvres including high speeds and deep dives which are often difficult to organise with a live target.

7) Full analysis is available from the trainer on the results of an exercise.

8) Manufacture of the equipment is to the highest standards and integrated circuit techniques are used for maximum reliability.

THORN BENDIX LIMITED
Industrial Electronics Division
Beech Avenue, New Basford, Nottingham, NG7 7JJ, England
Telephone: Nottingham 76123 Telex: 37142

THORN Bendix

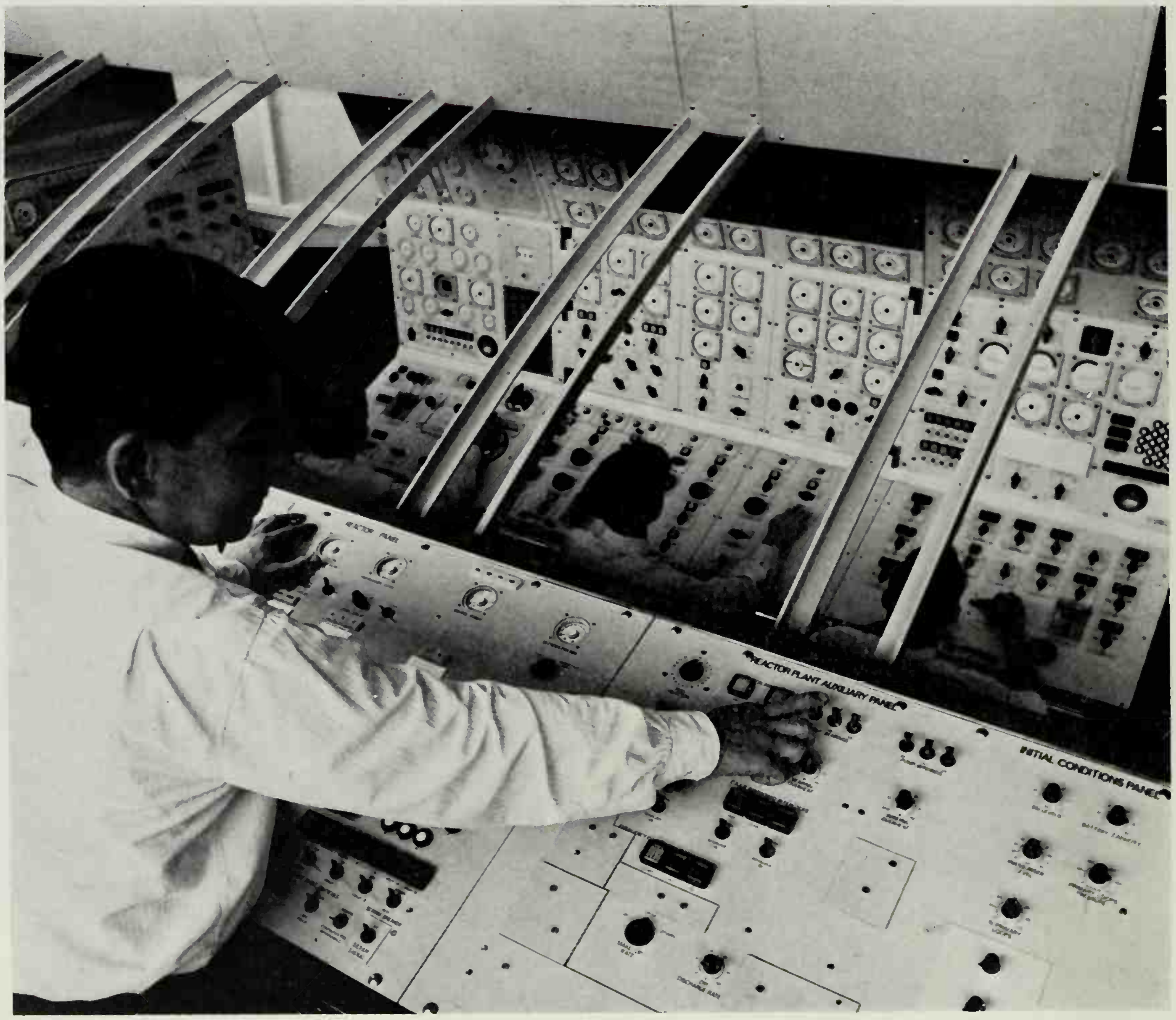
Naval simulators

for action and engine room training

Action information trainer
This action information simulation system enables two frigate destroyer command teams to be trained simultaneously but independently. The total exercise area is 1000 nautical miles square (1850 × 1850 km) and environmental conditions such as wind and tide apply over the complete playing area.

The trainer comprises the necessary equipment to simulate two 'own ship' models, together with independently controlled surface, aircraft, helicopter and sonar targets. A convoy configuration is also available.

Naval manoeuvring room training simulator
This system provides for complete simulation of the engine room and propulsion system operation of a submarine. All instrumentation is faithfully reproduced and the arrangement of consoles provides a realistic impression, complete with shipborne noises, of a manoeuvring room with the hull skin removed. The controller's view of the equipment is shown below.



A GEC-Marconi Electronics Company
MARCONI SPACE AND DEFENCE SYSTEMS LTD
Trainer and Simulator Division
Chobham Road, Frimley, Camberley, Surrey, England
Telephone: Camberley 63311   Cables: Elliotauto Camberley   Telex: 85289

Flight simulators

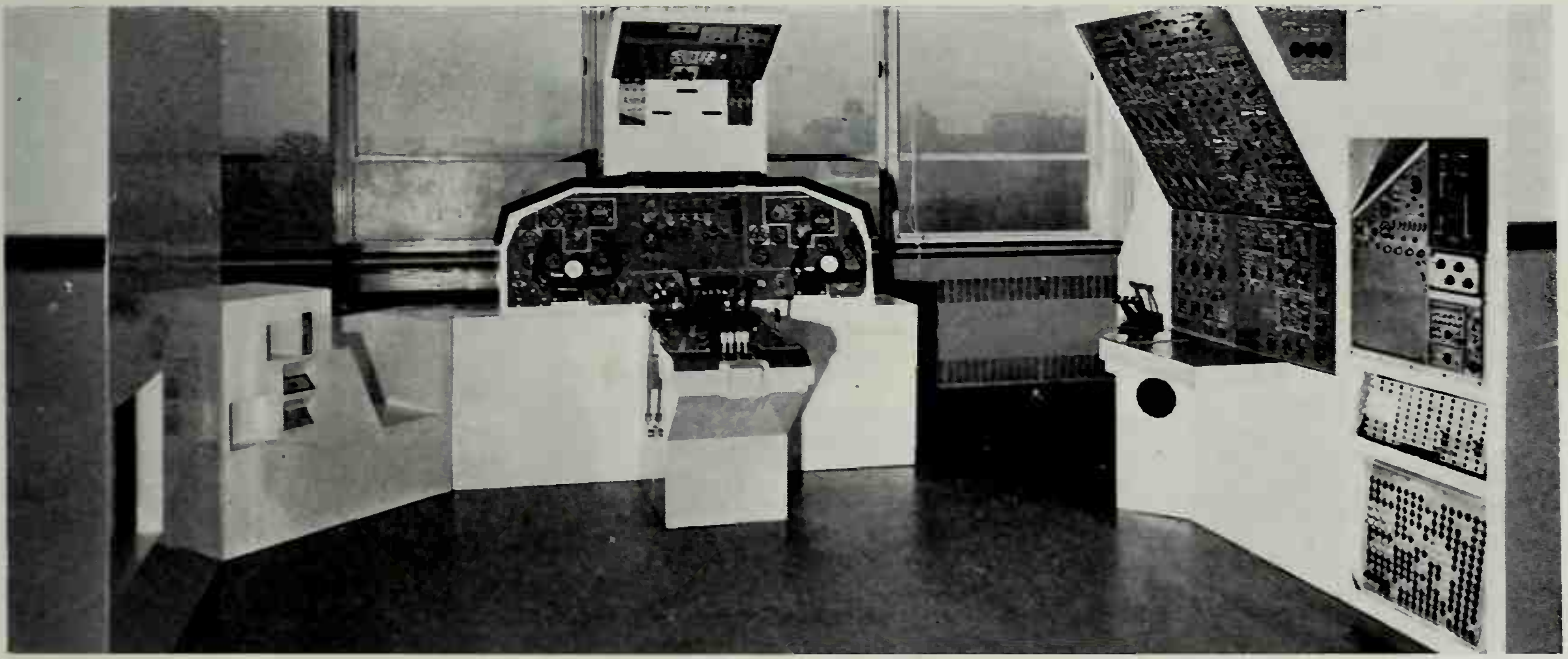
for crew and technical support training

Maritime aircrew trainer

At the present time the company is producing a number of maritime crew trainers for the Coastal Group of the Royal Air Force Strike Command. These trainers will provide realistic and comprehensive training facilities for crews of the Nimrod MR Mk 1 aircraft. The crew are able to use all their operational equipments, in a realistic setting, controlled by the instructors using an Elliott 4130 computer system. Full radar, sonar, electronic counter measures, communications, and tactical navigation simulation is provided.

Procedural trainers

Procedural techniques are an essentially practical approach to the training and exercising of operators and technicians. This is accomplished by repeating sequences of operations until the trainee reacts automatically to all circumstances that can be met in real life. Each trainer provides full-scale simulation of the control station panels and is equipped with all the controls and instruments of the systems being studied. Extensions of procedural trainers are available by the addition of visual displays. This allows the trainee to have both theoretical and practical coverage of the system.



Typical configuration of a procedural trainer suitable for training aircrews and technicians

Visual display trainers

Visual display trainers comprise modular displays for classroom use, providing a schematic of the system under study. They are animated by various methods, including the use of multi-colour illumination. The trainers illustrate the operation of the system in all modes possible in real life. An exact replica of the system control panel being studied enables the pupil to operate the trainer as if it was the real system. The pupil's actions trigger displays representative of the reaction of the components to the controls. Malfunctions can be fed in at any time by the instructor using fault switches. The use of these switches raises an immediate demand for diagnostic and corrective action to be taken by the pupil. A trainer of this type assists the instructor to accelerate the learning process. It also provides student exercise in handling drills and fault diagnosis. It is a suitable medium for training both operators and maintenance crews.

A GEC-Marconi Electronics Company
MARCONI SPACE AND DEFENCE SYSTEMS LTD
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Simfire

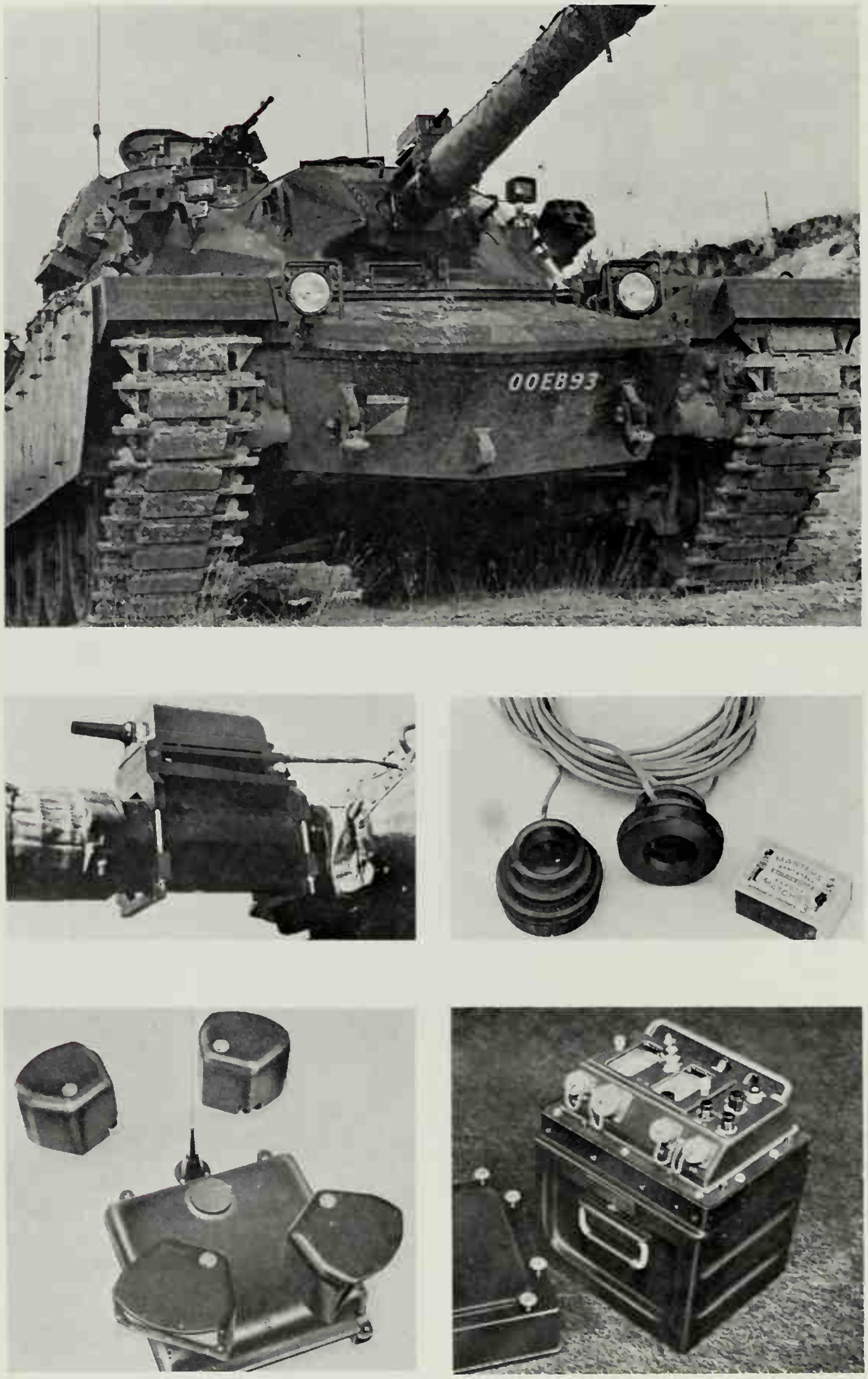
weapon effects simulator

The Solartron Simfire weapon effects simulator provides a high degree of realism on tactical exercises by enabling armoured fighting vehicles and direct fire weapon crews to engage and disable 'enemy' vehicles without the need to fire live ammunition. Another important application of the system is for gunnery training without the expense of firing live ammunition.

The equipment is inexpensive, robust and realistic. It imposes no limitations on armoured fighting vehicle performance or weapon drills, while allowing crew to carry out their normal combat tasks. It can be used in both tactical and range gunnery exercises with tanks, armoured cars, anti-tank guns and helicopters. Thus a multi-weapon exercise can be mounted with complete compatibility between the units involved, enabling full evaluation of training and operational concepts to be made. Both gunner and commander are given positive indication of fall of shot, and a hit can only be achieved if the weapon is correctly aimed and, in the case of moving targets, allowance made for aim-off.

Scoring does not rely on an umpire's decision and hit/kill indications are conveyed automatically to both the commander of the attacking unit and the crew of the unit under attack. Range gunnery training is catered for by specially equipped target screens used in conjunction with the weapon effects simulator. It is therefore practicable to replace many live ammunition training rounds at a very significant saving in ammunition cost.

Simfire is now in full production. It is already in use by the British Army and by the armies of five other nations.



The pictures show the British Chieftain tank equipped with the Solartron Simfire tactics kit (top) and the separate components of the kit, comprising the projector (centre left), the lamp indicator set (centre right), the R/T unit and detectors (bottom left) and the control unit (bottom right)

THE SOLARTRON ELECTRONIC GROUP LIMITED
Farnborough, Hampshire, England
Telephone: Farnborough 44433 Cables: Solartron Farnborough Telex: 85245

Simulators for anti-tank guided weapons

Avimo has designed, developed and manufactured simulators for command to line-of-sight optically guided anti-tank weapons, for both classroom and field use.

The simulators are used for initial training and continuation training (for ground and air simulated firings).

For classroom training the light spot which represents the missile flare is projected onto a screen. In field trainers and airborne trainers the light spot is injected into the operator's field of view in the sight. This can be done with either a servo drive mirror or a cathode-ray tube.

Twin-spot projectors have also been made; in this case both missile and target light spots are projected on to the inside of a dome.

Avimo Ltd
Herbert Street, Taunton, Somerset, England
Telephone: Taunton 81071
Cables: Avimo Taunton
Telex: 46126

Flight simulators and trainers, visual display systems, tank driving simulators

We manufacture a wide range of training equipment designed for and currently in use by military and commercial authorities throughout the world.

Flying training equipment manufactured includes instrument and navigation flight trainers, cockpit procedure trainers and full flight simulators.

Flight simulators can, if required, be supplied with operationally proven motion systems, full visual display systems in monochrome or colour, and can incorporate analogue or digital computation.

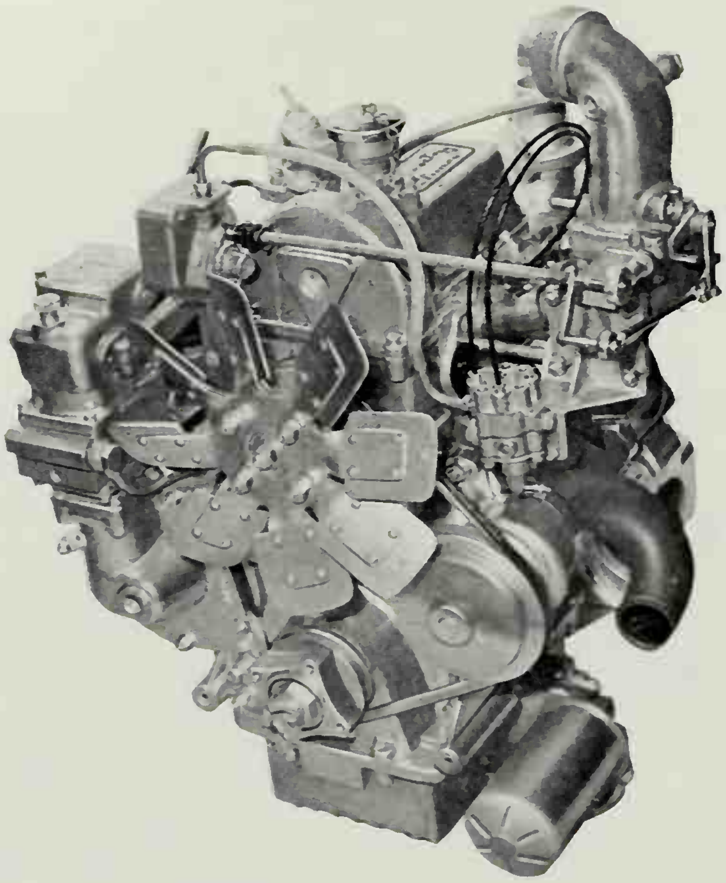
Simulators are currently in operational use for Sea Vixen, Buccaneer, Belfast, C-130K Hercules, Sea King (helicopter) and Harrier (VTOL).

Tank driving simulators developed and manufactured by Link-Miles Ltd have been operationally proven by the British Army over the past five years.

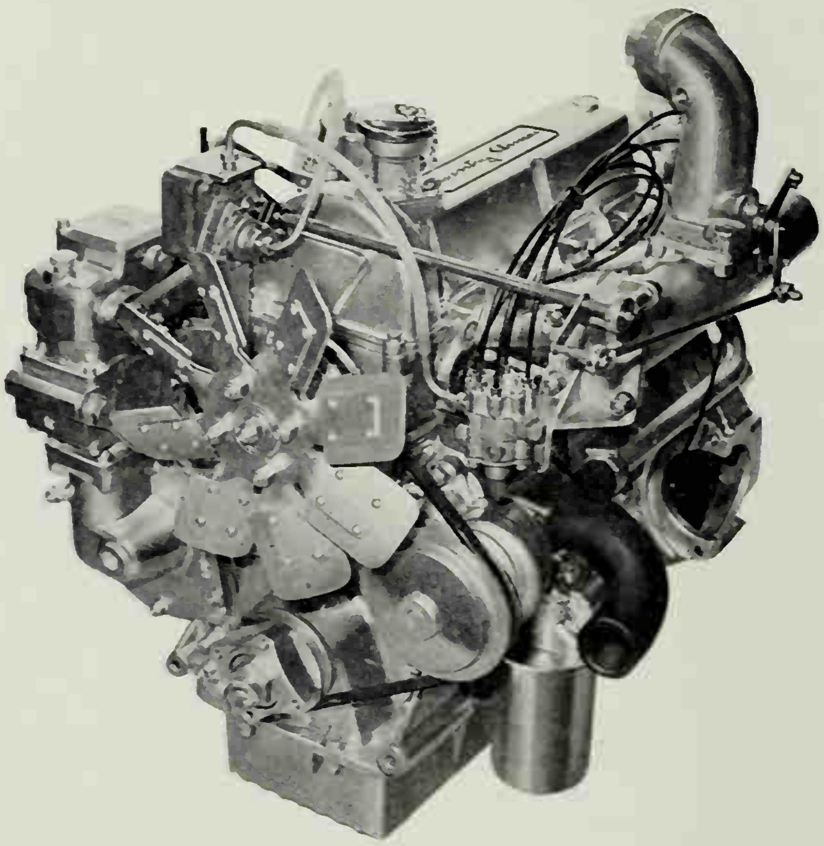
Link-Miles Ltd
Churchill Industrial Estate, Chartwell Road, Lancing, Sussex, England
Telephone: Lancing 5881
Telex: 87165

Section 27

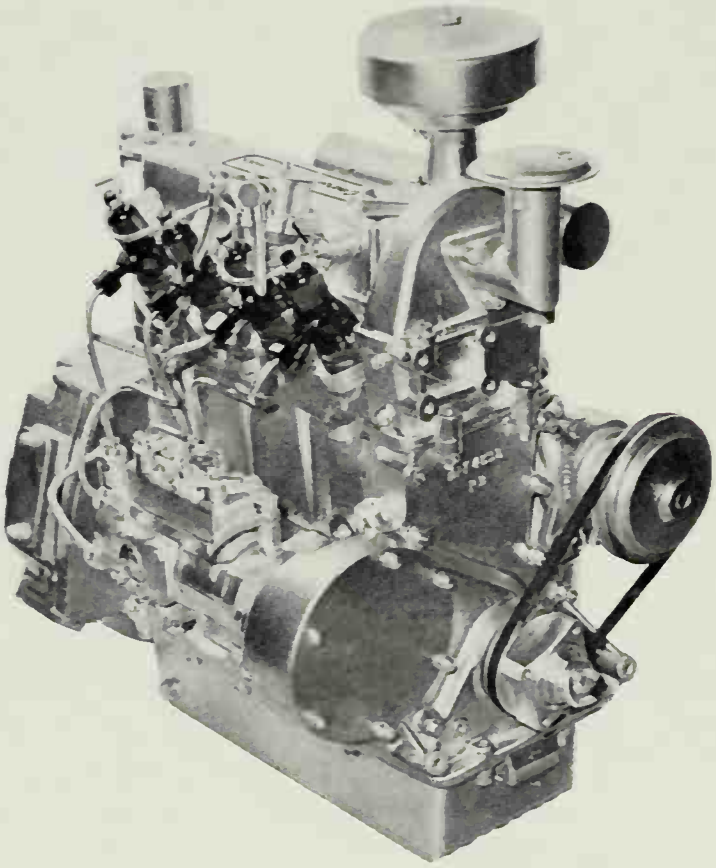
Internal combustion engines



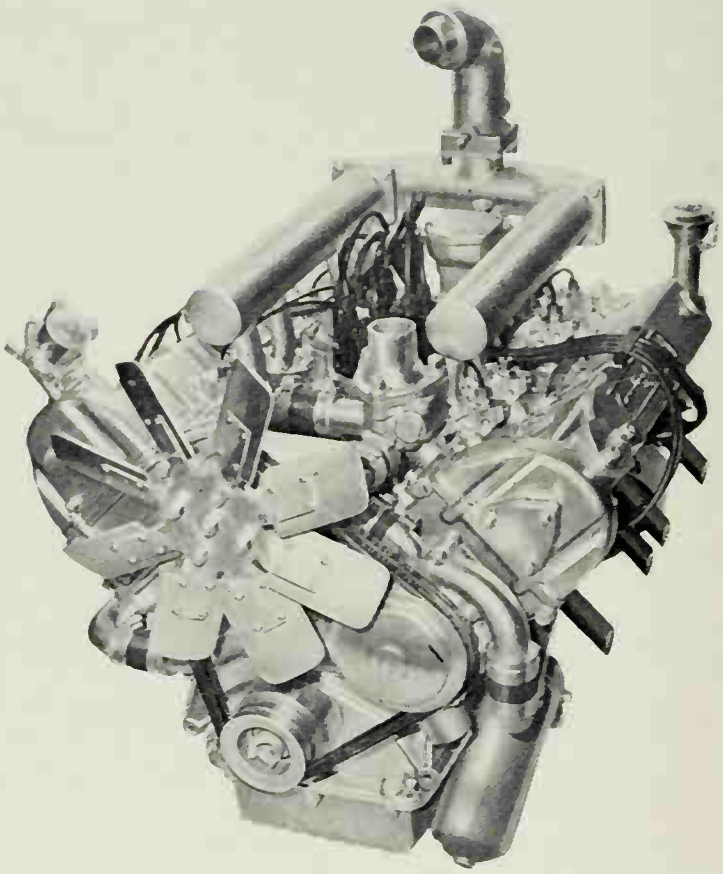
AFF twin-cylinder gasolene engine



BFF four-cylinder gasolene engine



BFFD four-cylinder diesel engine



CFF V-8 cylinder gasolene engine

Military engines

Gasolene and diesel range for military use

This new range of Coventry Climax engines, developed in collaboration with the Military Engineering Experimental Establishment, is designed to utilise a majority of common working parts. Of high performance and low weight, the engines are intended to power portable units such as generating sets and pump sets. The range comprises 2, 4 and V8-cylinder spark-ignited models running on aircraft turbine fuels of gasolene or kerosene type. In addition, the range is available in diesel (compression ignition) form.

These lightweight high-speed engines have been developed over a long period; both diesel and gasolene versions have been running satisfactorily for many years in slightly smaller capacity, namely 185 cm^3 (11·29 in^3) compared with 226·5 cm^3 (13·82 in^3)/cylinder. The four-cylinder version in 742 cm^3 (45·28 in^3) form has for many years powered the Godiva FWMP portable fire pump which is in use in large quantities throughout the world. This four-cylinder engine became the development unit for the 1$\frac{1}{2}$-litre and 2-litre (91·53 and 122 in^3) V8 Grand Prix engines which have been so successful in motor racing, winning the World Championship in 1963 and 1965. The V8 in the new range is basically similar to these race-winning engines.

Commonality of parts

To facilitate maintenance and parts stocking, particular attention has been given to the widest possible common use of components.

The 2, 4 and 8-cylinder engines have the following parts in common: connecting rods and bolts; pistons and rings; gudgeon pins, bushes, etc.; connecting rod bearings; valves, valve springs; tappets, spring collars; main-bearing liners and thrust washers; flywheels, starter rings; governor; ignition drives; ignition distributor assembly; fastening bolts, studs, etc. (Note.—The V8 connecting rod differs slightly in respect of the width of the big end eye, but for emergency use those used for the 2 and 4-cylinder models can easily be modified by removal of small abutment faces.)

The 2 and 4-cylinder engines have the following parts in common: camshaft timing drive, casing; chain drive sprockets; housing and drive for distributor; fuel injection pump, governor, gears, shafts, etc.; oil pump drive; coolant pump and drive.

Components special for each engine are: cylinder block; cylinder heads; cam cover; crankshafts; tappet blocks; camshafts; oil pumps; exhaust and inlet manifolds; cylinder head gaskets. (Note.—On the V8 the cylinder heads are identical for each bank of cylinders. They are asembled in reverse direction for either side. The camshafts and tappet blocks are also common to both sides.)

Specification

Model designation	Fuel	Maximum bhp	Speed	Engine form	2 or 4-stroke	No of cylinders	Valves per cylinder	Cylinder bore	Piston stroke	Full-load bmep	Piston speed at maximum rev/min	Engine weight (without gear)	Overall length	Overall width	Overall height
			rev/ min					mm (in)	mm (in)	kg/cm^2 (lb/in^2)	m/sec (ft/min)	kg (lb)	mm (in)	mm (in)	mm (in)
AFF	Gaso.	25	6000	In line	4	2	2	67·31 (2·65)	63·5 (2·5)	10·05 (143)	12·7 (2500)	45·36 (100)	470 (18·5)	457 (18)	584 (23)
AFFD	Diesel	12	6000	,,	4	2	2	67·31 (2·65)	63·5 (2·5)	5·41 (71)	12·7 (2500)	45·36 (100)	470 (18·5)	457 (18)	584 (23)
BFF	Gaso.	50	6000	,,	4	4	2	67·31 (2·65)	63·5 (2·5)	10·05 (143)	12·7 (2500)	68 (150)	635 (24·5)	508 (20)	609 (24)
BFFD	Diesel	27	6000	,,	4	4	2	67·31 (2·65)	63·5 (2·5)	5·41 (71)	12·7 (2500)	68 (150)	635 (24·5)	508 (20)	609 (24)
CFF	Gaso.	100	6000	Vee 90°	4	8	2	67·31 (2·65)	63·5 (2·5)	10·05 (143)	12·7 (2500)	113·4 (250)	760 (30)	635 (24·5)	710 (28)
CFFD	Diesel	54	6000	Vee 90°	4	8	2	67·31 (2·65)	63·5 (2·5)	5·41 (71)	12·7 (2500)	113·4 (250)	760 (30)	660 (26)	710 (28)

COVENTRY CLIMAX ENGINES LTD
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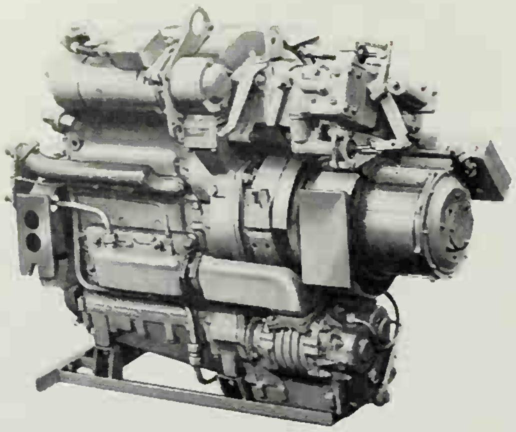
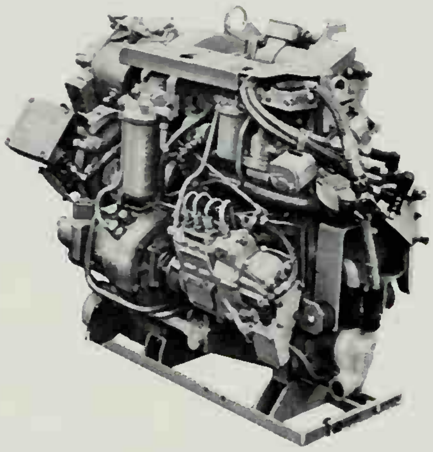
BRITISH
LEYLAND

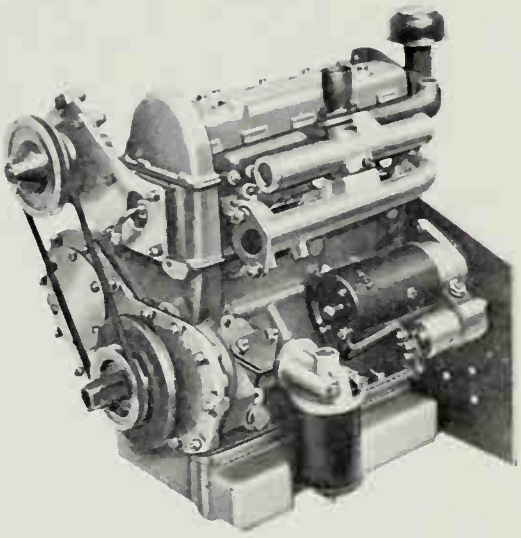


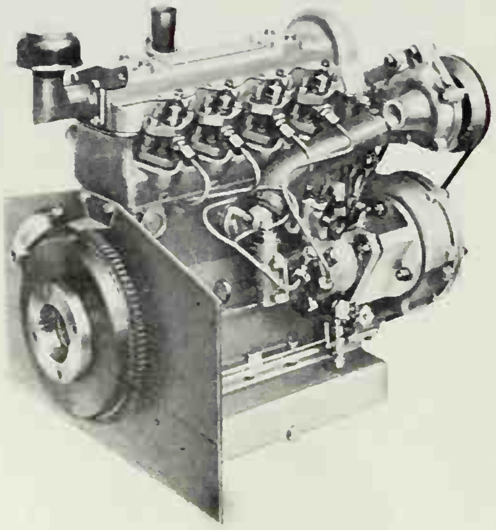


H30 engine

Maximum bhp	37·5
Speed	3000 rev/min
Engine form	In-line, opposed pistons
2 or 4-stroke	2
No of cylinders	3
Cylinder bore	55 mm (2·166 in)
Piston stroke	69·85 mm (2·75 in)
Full-load bmep	5·76 kg/cm^2 (82 lb/in^2)
Piston speed at maximum rev/min	7·0 m/sec (1375 ft/min)
Engine weight (without gear)	226·8 kg (500 lb)
Overall length	851 mm (33·5 in)
Overall width	503 mm (19·8 in)
Overall height	819 mm (32·25 in)

FWMD engine





Maximum bhp	20
Speed	5000 rev/min
Engine form	In-line
2 or 4-stroke	4
No of cylinders	4
Valves per cylinder	2
Cylinder bore	64·3 mm (2·53 in)
Piston stroke	57·2 mm (2·25 in)
Full-load bmep	4·92 kg/cm^2 (70 lb/in^2)
Piston speed at maximum rev/min	11·44 m/sec (2·25 ft/min)
Engine weight (without gear)	72·6 kg (160 lb)
Overall length	623 mm(24·5 in)
Overall width	508 mm (20 in)
Overall height	610 mm (24 in)

Small military engines

multi-fuel and diesel

H30 multi-fuel engine

The H30 was designed by Sir W G Armstrong Whitworth & Co (Engineers) Ltd, in conjunction with Coventry Climax Engines Ltd, who have been responsible for its development and production with the British Ministry of Defence, who laid down the basic specification and multi-fuel requirements of the engine.

Auxiliary set for the Chieftain tank

The engine was primarily designed as the auxiliary power unit in the Chieftain tank which employs a Leyland L60 multi-fuel engine as its main power unit. In this form the H30 drives a Rotax generator-alternator at 4000 rev/min, producing 10 kW dc and 1·5 kW ac. It also drives on selection, and at the engine crankshaft speed of 2000 rev/min, an hydraulic pump which powers the starter of the main power unit.

In its role as an auxiliary power unit for the Chieftain tank it is asked to provide 30 bhp for a limited period at a crankshaft speed of 2000 rev/min. The engine is, however, capable of satisfactory running at 3000 rev/min, giving higher outputs.

Construction

The engine is extremely well balanced and those out-of-balance forces caused by phasing produce no serious problem even in the higher speed ranges. The inherent advantages of piston phasing enable the fuel to be burned at constant or near-constant volume for part of the cycle, thus helping the engine to accommodate the ignition delay of low-octane fuels. A further inherent advantage when compared with the valve-in-head engines (where limitations are imposed by the mechanics of the valve gear) is the high rate of exhaust port opening and closing so essential for an efficient high-speed two-stroke cycle engine. The combustion chamber is formed almost entirely between the two well-insulated pistons and is compact, with minimum heat losses. This, coupled with the high rate of swirl induced by the tangentially directed air-ports, assists the opposed-piston engine to obtain good combustion on light fuels.

Startability

The H30 has been designed so as to reduce heat losses to a minimum. A metered supply of lubricating oil can be sprayed into the cylinder and on to the liner walls during engine cranking, thus sealing air leakage past the piston and resulting in starting at temperatures of 0°C, within reasonable cranking time. For starting at temperatures below 0°C, a Start Pilot ether primer is provided.

The 24 V electric starter motor for the Mk 1A engine is of the oil-sealed type and engages directly with the gear ring mounted on the exhaust flywheel. The starter ratio is 8·2 to 1. Provision is being made for starting the engine by directly hand-cranking the exhaust crankshaft. The hydraulic pump for powering the Leyland L60 main engine starter is driven, when required, from the exhaust crankshaft by a sleeve mechanism which couples the crankshaft to the pump. It is controlled from the driver's compartment and is locked to prevent inadvertent engagement when the engine is running.

Vehicle development suggested that the H30 engine should be lowered within the hull of the tank, and this has been accomplished by removing the underslung oil tank of the Mk 1A and by repositioning the Roots-type blower. Greater flexibility is therefore provided in the gear-drive from the air crankshaft to the blower which runs at 1.818 times crankshaft speed.

FWMD high-speed diesel engine

This power unit has been developed from the well-known Coventry Climax FW series of petrol engines which are employed in the famous Godiva fire pumps. Automotive versions of these engines have gained outstanding prominence in motor racing.

Weighing only 68·4 kg (158 lb) in bare form, the new 750 cm^3 four-cylinder diesel engine has already been used to power a portable fire pump with an output of 796 litre/min at 7 kg/cm^2 (175 gal/min at 100 lb/in^2); having an overall weight of only 145 kg (320 lb) it is easily handled by two men.

Construction

LM8 aluminium alloy is employed for the cylinder block, cylinder head and sump in the interests of weight reduction. Although aluminium construction is entirely satisfactory with regard to crankcase rigidity it can create starting difficulties owing to the high rate of heat dissipation. To overcome this difficulty the unit is fitted with a Start Pilot capsule, facilitating cold-weather starts.

The problem of metering and injecting the extremely small quantities of fuel required by cylinders of less than 188 cm^3 capacity has been successfully overcome. The unit is equipped with a CAV DPA distributor-type pump. Nozzles of the standard pintle type are employed, although advantage could be taken of smaller nozzles if they became available.

Performance and operation

The most important factor in achieving the unit's favourable power-to-weight ratio is not the light-alloy construction, but the ability to operate at high crankshaft speeds. Whereas the engine is rated to produce 20 bhp at 5000 rev/min running on gasoil, it has been operated experimentally at 6000 rev/min, developing 25 bhp.

The engine operates successfully both on part load throughout the speed range and on full load at around maximum rev/min.

Operating on gasoil with a high sulphur content does not create cold corrosion problems because the running temperature of the oil and coolant (about 80°C) is quickly attained.

Commonality with petrol engine

The crankcase scantlings of the petrol version on which the FWMD is based are more than adequate for the combustion pressures of the diesel cycle by virtue of the petrol unit's high bmep and operating speed. Overhead camshaft for valve operation offers reliability and long life under peak load conditions, as proven by the performance of petrol-driven versions of this engine, which in automotive form have been uprated to develop 65 bhp at 8000 rev/min. A unit of this type was fitted to the Lotus that won the Index of Performance at Le Mans in 1957.

Detailed features of the unit that are common with those of the petrol engine include aluminium pistons with two compression rings and one oil-control ring above the gudgeon pin (the crowns of the diesel engine pistons are cut away to accommodate valve openings) and slip-fit cast-iron liners. The three-bearing crankshaft is fully counterbalanced. The oil pump is driven by a spur gear from the front end of the crankshaft and separate tension-controlled chain drives are provided for the camshaft and injection pump. Big-end and main bearings are of the Glacier tin-aluminium or Vandervell VP2 type and the valve inserts are of austenitic iron.

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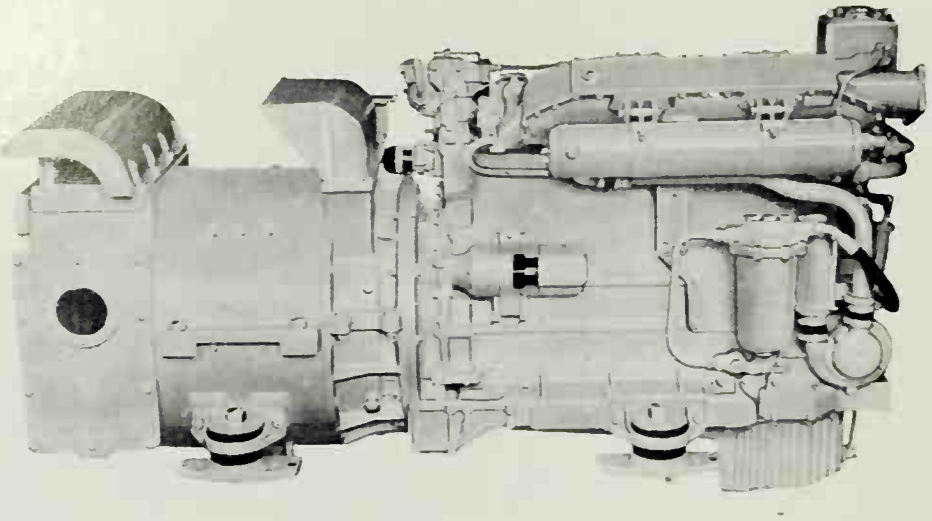
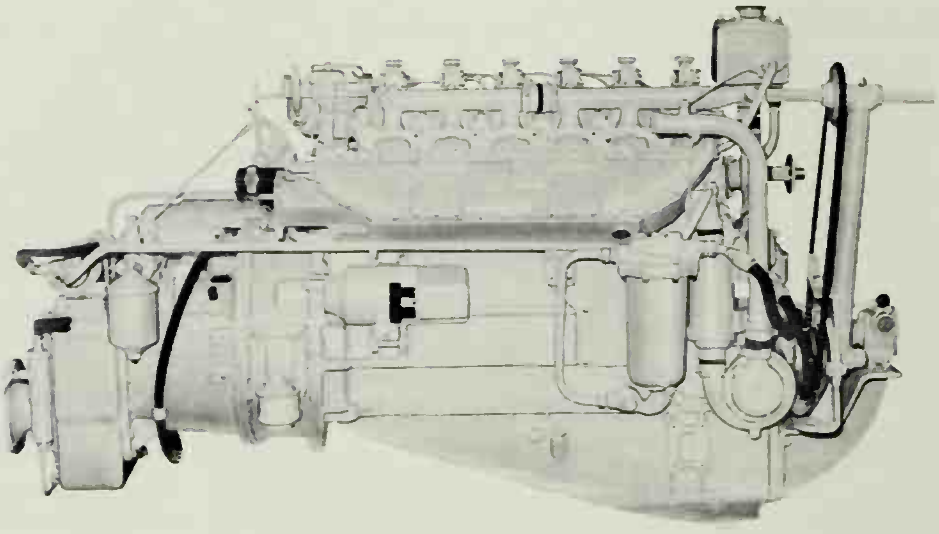
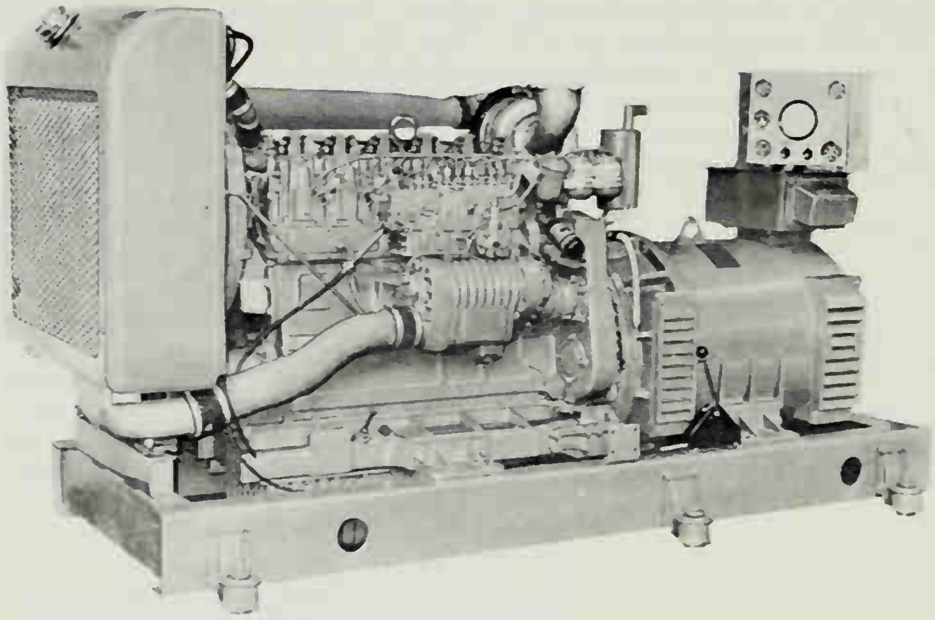


Foden Type FD.6 Mk 6 marine generating set with 84 kW output. Dry weight is 1450 kg (3200 lb)

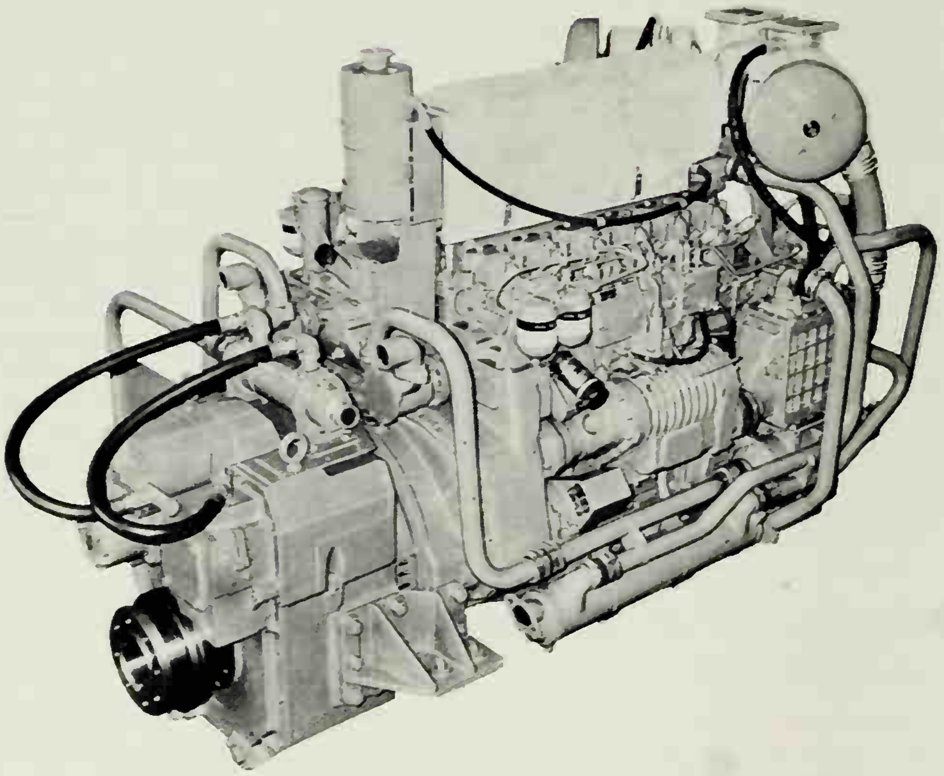
FD.6 Mk 6 propulsion engine as fitted in Royal Navy survey boats. It weighs 866 kg (1910 lb) and is fitted with hand-starting gear





FD.6 Mk 7 radiator-cooled emergency power generating set of 120 kW capacity. Weight is 1967 kg (4340 lb)

FD.12 Mk 7 propulsion engine used as cruising engine in combined diesel-and-gas (CODAG) installations. Weight is 2087 kg (4600 lb)



Diesel engines

for marine propulsion, power and industry

Foden diesel engines within the power range from 84 to 440 bhp are used throughout the world for marine propulsion, electric power generating and industrial duties.

All engines in this range have the same bore and stroke (92 × 120 mm) and major components are interchangeable. This offers obvious advantages in spares back-up when these engines are used as defence equipment.

The Mk 6 engines are mechanically blown two-stroke cycle, manufactured in 4, 6 and 12-cylinder sizes. The Mk 7 engines, in 6 and 12-cylinder sizes, are exhaust turbo-charged.

These engines have a service life at full power of 10 000 hours between overhauls and, due to weight saving by the use of light alloy castings and small size resulting from the two-stroke cycle of operation, their weight/bhp and size/bhp ratios are outstandingly low. These features are further advantages when used as naval defence equipment because they facilitate refit-by-replacement procedures.

Design features are as follows:

Crankcase

An aluminium alloy casting, fitted with centrifugally cast wet liners. All firing loads are carried on steel through-bolts which form the cylinder head holding-down bolts at the top end and the main bearing studs at the bottom end.

Bearings

Aluminium-tin shell-type main and big-end bearings.

Cylinder heads

A separate cylinder head is used for each cylinder.

Crankshaft

This is a nickel steel forging machined all over.

Fuel injection system

A unit fuel injection pump with hydraulic governor is used, with fuel lift and excess fuel return pumps. Fuel injectors are carried in the cylinder heads so that they may be removed without disturbing other fittings and it is impossible for fuel leaks to contaminate the lubricating oil.

Lubrication

Fully automatic with full-flow filtration. The oil cooler is situated in the fresh water cooling system, so that the water thermostats also control the lubricating oil temperature.

Cooling

Marine engines are heat-exchanger cooled with a centrifugal fresh-water pump and a displacement type sea-water pump. Industrial and harbour duty engines are radiator-cooled. Both types of cooling systems are designed to conform with the most severe tropical conditions.

Starting

All engines are fitted with a 24 V dc starter system.
All engines can start at –7°C (20°F) without starting aids.

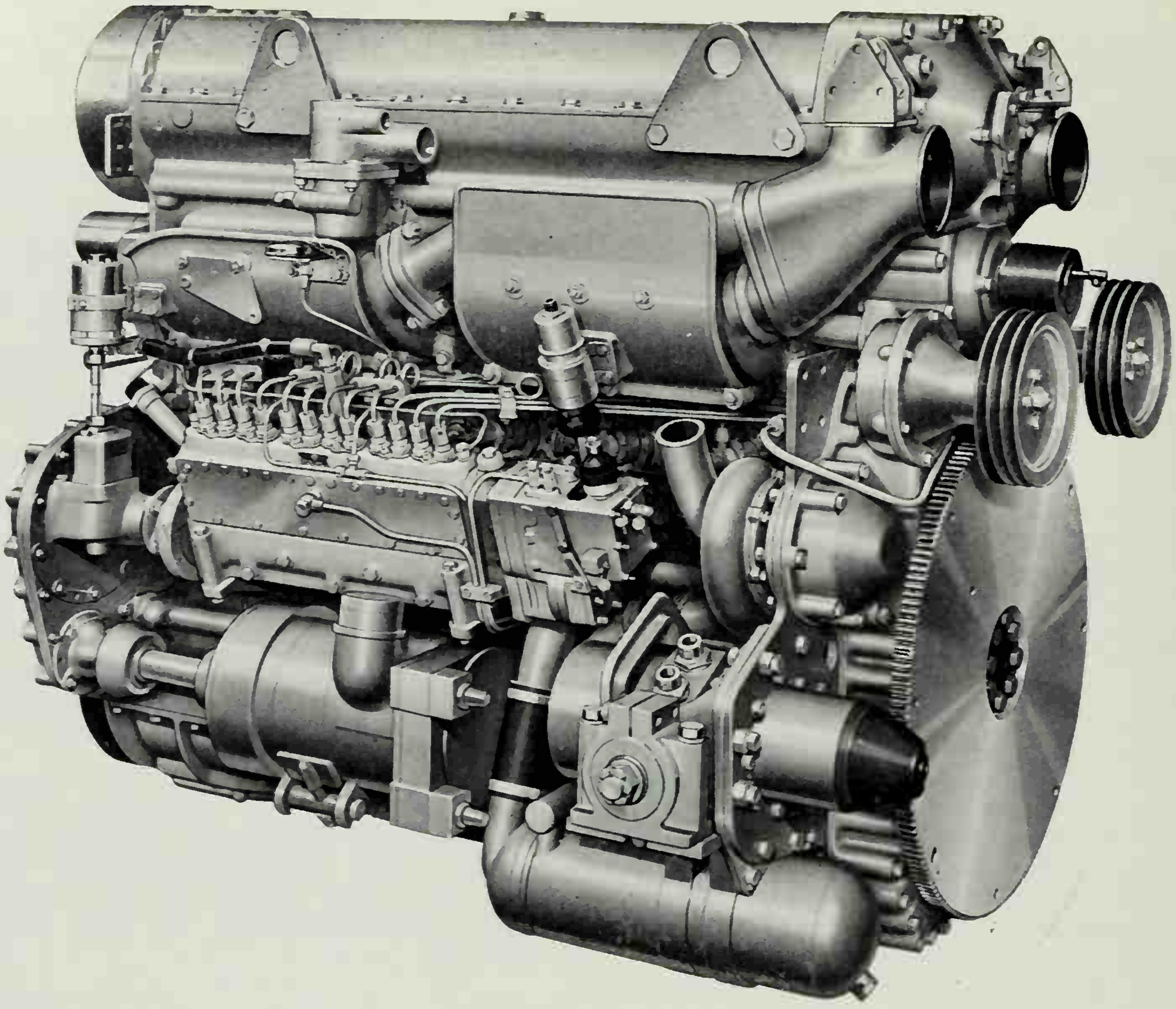
Hand-starting gear, consisting of decompression equipment and cranking handle, is available on all 4 and 6-cylinder engines.

Engine ratings

All ratings are in accordance with the requirements of British Standard BS649:1958.

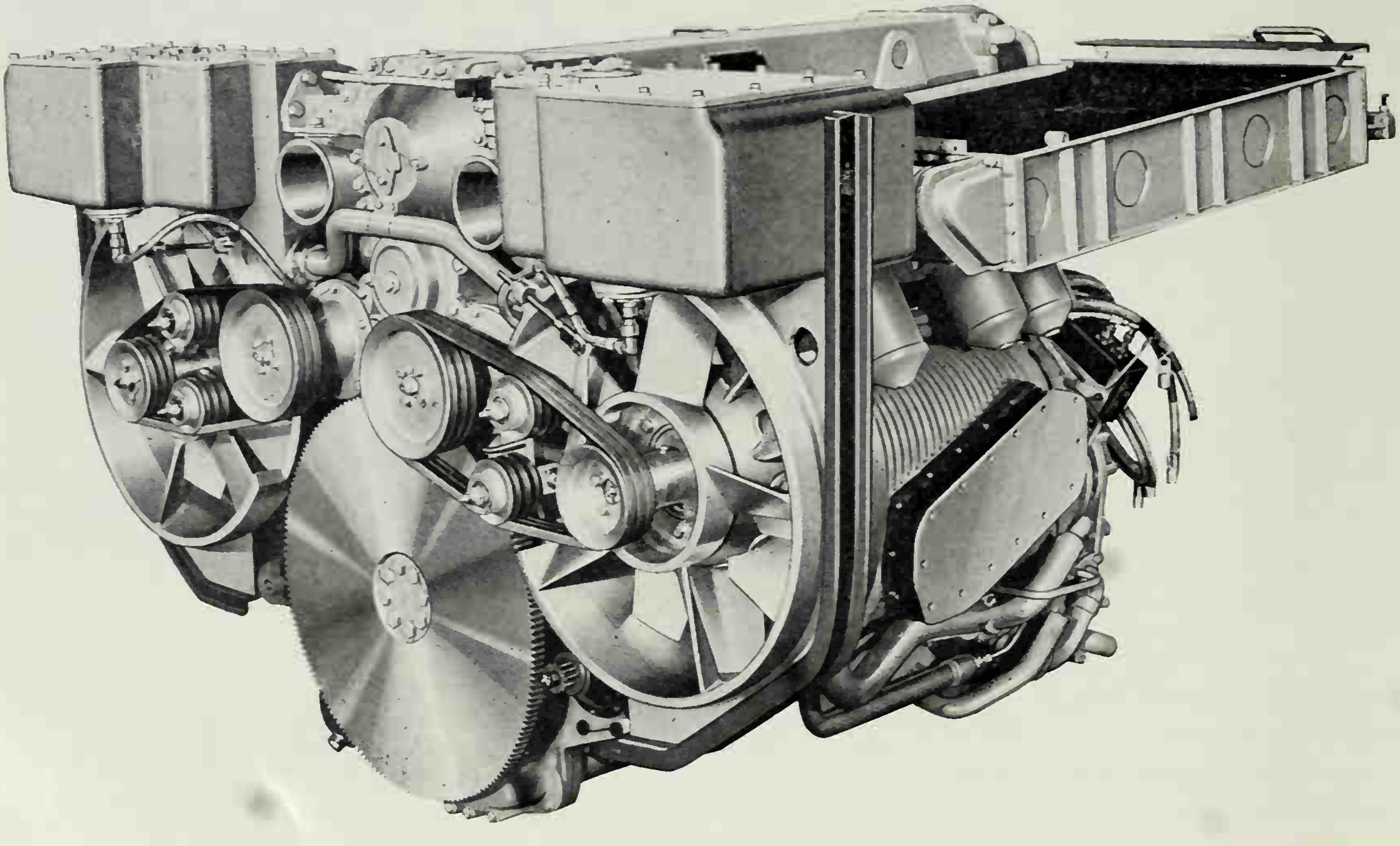
Type	**Marine propulsion—shaft hp**			**Generator—kW**	
	Continuous 1800 rev/min	12 hour 2000 rev/min	Intermittent 2000 rev/min	50 Hz or dc 1500 rev/min	60 Hz or dc 1800 rev/min
FD.4 Mk 6	81	90	100	48	56
FD.6 Mk 6	122	136	150	71	84
FD.6 Mk 7	182	—	213	100	125
FD.12 Mk 6	244	271	300	143	168
FD.12 Mk 7	364	—	427	200	250

FODENS LIMITED
Marine Department
Elworth Works, Sandbach, Cheshire, England
Telephone: Sandbach 3244 Cables: Fodenway Sandbach Telex: 36163



The Leyland L.60 multi-fuel engine in standard form

The Leyland L.60 engine as a power pack for use in fighting vehicles. The radiators are hinged and can be swung up to give access to the engine auxiliaries



Multi-fuel engine

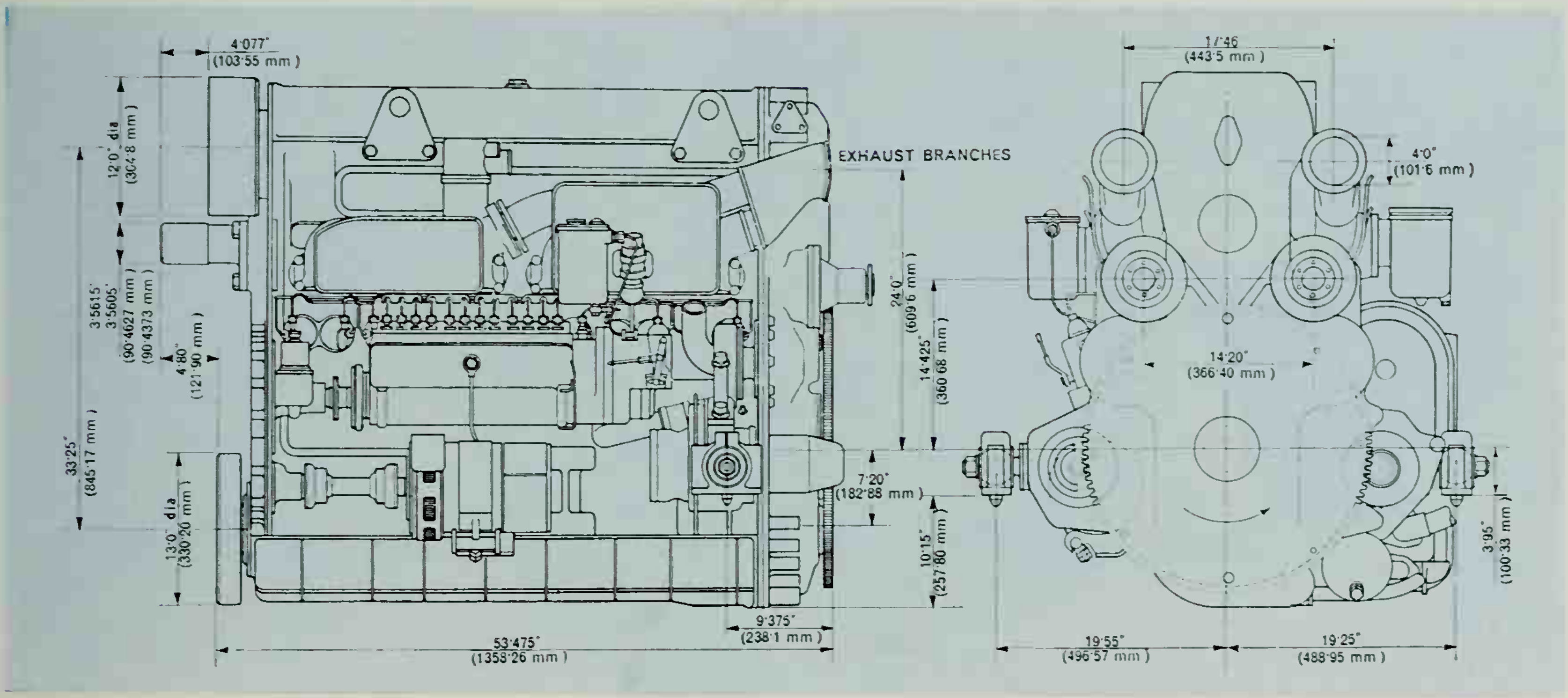
Leyland L.60 700 bhp

Conforming to specifications laid down by the British Fighting Vehicle Research and Development Establishment, the Leyland L.60 engine is designed to run satisfactorily on a wide range of fuels and consumes a higher proportion of the hydrocarbons available in crude oil than is possible with current designs of piston engines.

Even when running on lower grade petroleum fuels, the Leyland L.60 engine is comparatively quiet, starts easily and has a high power output. Research and development work on the L.60 engine was initially undertaken by Leyland Motors Ltd to produce a reliable power unit to meet the rapidly increasing demands for an engine suitable for use in various spheres of military operation. It has the advantage also of limited industrial application, especially in those territories where, for economic or geographical reasons, it is essential to have a power unit which can be run on whatever fuel is in plentiful supply at any one moment. A power rating as high as 700 bhp can be achieved for certain duties.

Despite the compact envelope dimensions of the engine, sufficient drives and power take-off points have been provided to enable a range of auxiliaries to be fitted which make the unit suitable for use in varied applications.

The engine has been accepted for use in military vehicles and powers the Chieftain battle tank.



Design details

The L.60 is a vertical water-cooled six-cylinder engine with wet cylinder liners in a monobloc casting combining crankcases and cylinder block. A twin crankshaft layout has been adopted using conventional connecting rods for each piston. The upper (exhaust) crankshaft is coupled to the lower by a train of gears. The starter ring and output shaft are driven from one of the intermediate gears in this train.

A Rootes-type positive-displacement triple-lobe scavenge blower is driven from an auxiliary gear train at the front on the engine which also drives the lubricating oil pumps and generator.

From the blower inlet air enters a large air manifold and passes through the cylinder inlet ports which are arranged to give a pronounced swirl to the ingoing charge. The engine port timing is designed to allow the charge air to scavenge exhaust gases from the cylinders before the exhaust ports are covered by the upper pistons on their compression stroke.

An in-line 12-element fuel injection pump and hydraulic speed governor are driven from the auxiliary gear train, feeding two injector nozzles in each cylinder. One set of nozzles provides injection in advance of main fuel injection to assist combustion propagation.

The lubrication system works on the dry sump principle with lubricating oil circulated round the engine by a gear type pump and returned to a storage tank by a separate scavenge pump from the engine sump. The circuit incorporates triple cloth element filters, a centrifugal filter and a heat exchanger.

Each piston is a two-piece unit comprising a high grade heat-resisting steel crown spigoted to the cast iron piston body. Both crankshafts are forged from chrome-molybdenum and are hardened by nitriding.

The cooling system is pressurised.

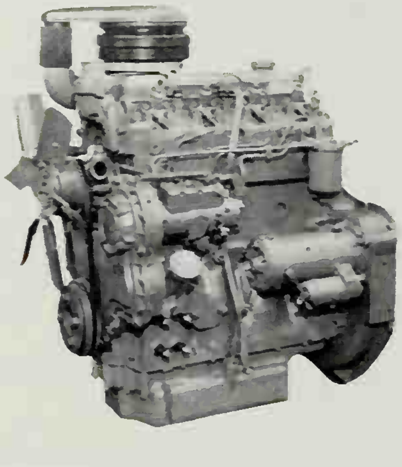
A heavy-duty starter motor is fitted. A wide range of optional equipment is available.

Specification

No of cylinders: 6
Bore × stroke: 117·5 × 146 mm (4·625 × 5·75 in)
Cubic capacity: 19 litres (1160 in³)
Max horsepower rating: 700 bhp
Max torque (net): 218 kgf m (1580 lbf ft) at 1400 rev/min
Compression ratio: 16·75 to 1
Firing order: 1, 6, 2, 4, 3, 5
Rotation: counter-clockwise viewed from flywheel
Crankshaft speed: 2100 rev/min
Output speed: 2625 rev/min
Idling speed: 400 rev/min
Weight (including starter and generator): 1928 kg (4250 lb)

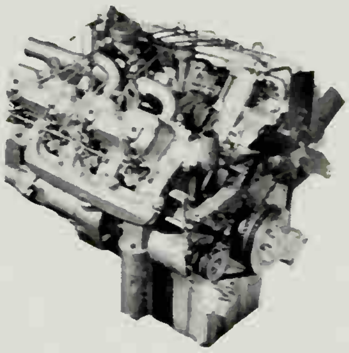
LEYLAND MOTORS LIMITED
Military Sales Division
Berkeley Square House, Berkeley Square, London W1, England
Telephone: 01-499 6050 Cables: Leymotors London W1 Telex Telex: 22498

Perkins range of industrial engines



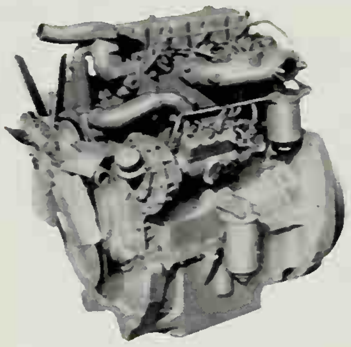
DETAILS	4.99 (I)	4.107 (I)	4.108 (I)	3.152 (I)	D3.152 (I)	4.203 (I)	4.236 (I)	4.248 (I)	4.270 (I)	6.354 (I)	T6.354 (I)
Continuous gross bhp at											
1200 rev/min	—	—	—	22·5	22·5	30	38	41	39	54	—
1500 ,,	18	19	19	28	28·5	37	48	51	46	66	89
1800 ,,	21·5	23·5	24	32·5	33	43·5	56	59	53	77	105
2000 ,,	24	26·5	27	35	36	47	61	64	57	83	113
2250 ,,	27	29·5	30	37	39	50	65	69	—	90	117
2400 ,,	29	31	31·5	—	—	—	—	—	—	—	—
3000 ,,	34	36	38	—	—	—	—	—	—	—	—
Max intermittent gross bhp	39	41	43	43	47	60	78	82	62	110	135
at rev/min	3000	3000	3000	2400	2500	2400	2500	2500	2000	2500	2250
Max torque											
kgf m	10·1	10·9	11·1	15·5	15·7	20·8	26·7	28	26·3	36·6	49·4
lbf ft	73	79	80	112	113	150	193	202	190	272	356
Dry weight kg	150	150	150	204	204	236	265	265	327	375	408
(bare) lb	330	330	330	450	450	520	585	585	722	825	900

Perkins range of transport engines



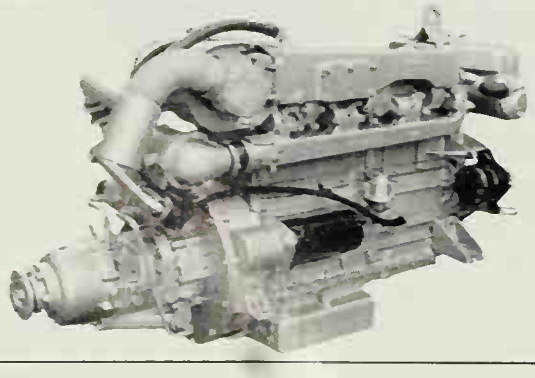
DETAILS		4.108 (V)	4.154 (V)	4.203 (V)	4.236 (V)	6.354 (V)	V8.510 (V)
Gross bhp		52	62/70	63	80	120	150/170
at rev/min		4000	3000/3600	2600	2800	2800	2000/2800
Max gross torque	kgf m	10·9	15·6	20·6	26·7	36	52·3
	lb ft	79	113	149	193	260	378
	at rev/min	2000	2000	1350	1400	1400	1600
Dry weight, bare engine with dynamo but without starter motor flywheel and flywheel housing	kg	150	195	216	263	380	607
	lb	330	430	477	580	836	1340

Perkins range of agricultural engines



DETAILS		D3.152 (TA)	4.107 (TA)	4.154 (TA)	D4.203 (TA)	4.236 (TA)	4.248 (TA)	4.270 (TA)	6.354 (TA)	T6.354 (TA)	V8.510 (TA)
Gross bhp		21/47	22/41	38/62	29/62	36/78	37/82	36/62	51/110	120/135	80/163
at rev/min		1000/2500	1500/3000	1800/3000	1000/2300	1000/2500	1000/2500	1000/2000	1000/2500	1800/2250	1200/2500
Max torque	kgf m	16·9	10·9	15·6	22·2	26·7	28	26·3	37·6	49·4	52·3
	lbf ft	122	79	113	161	193	202	190	272	356	378
at rev/min		1300	1900	2000	1300	1400	1400	1000	1400	1600	1600
Dry weight	kg	204	150	195	236	265	265	303	375	408	607
(bare)	lb	450	330	430	520	585	585	680	825	900	1340

Perkins range of marine engines



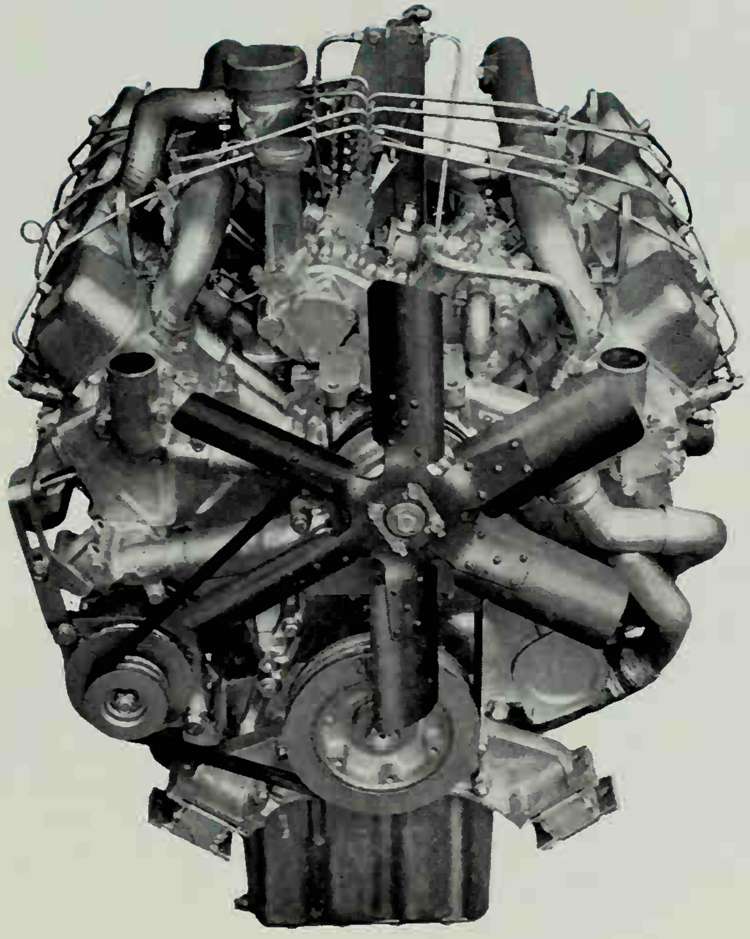
DETAILS	P3.152 (M)	4.107 (M)	4.108 (M)	4.236 (M)	6.354/ H6.354 (M)	T6.354/ HT6.354 (M)	V8.510 (M)
Shp	21/33	25/47	26/49	36/72	52/115	106/145	78/160
at rev/min	1200/2000	2000/4000	2000/4000	1200/2500	1200/2800	1800/2400	1200/2800
Dry weight (installed) kg	455	224	229	452	580/600	659/676	910
lb	1002	495	505	996	1280/1320	1450/1490	2000

Diesel engines

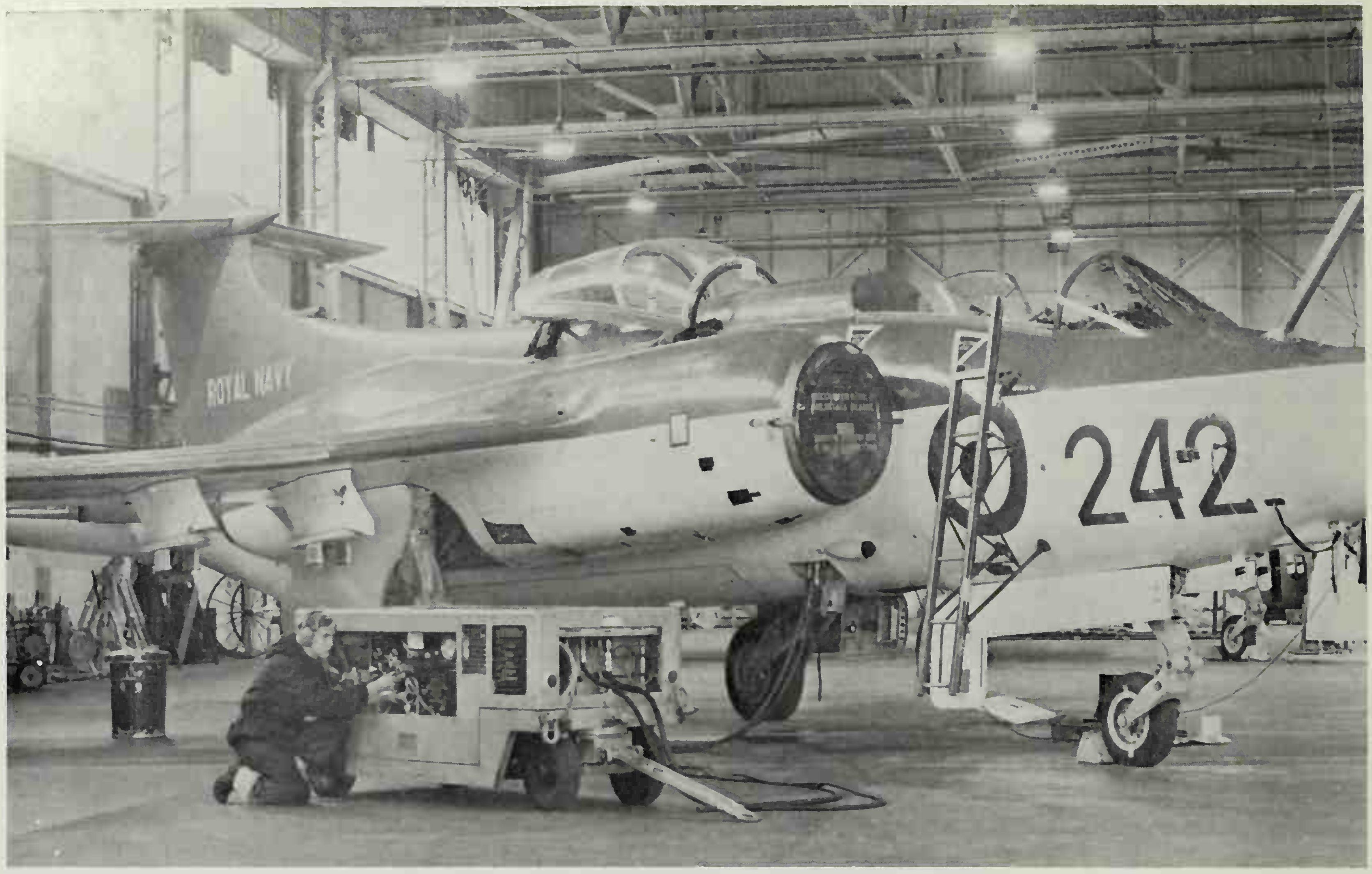
multi-purpose power units

Perkins Diesel Engines Limited is a worldwide leader in the manufacture of high-speed diesel engines. Production facilities operate in twelve countries, while two major plants, a modern research and development complex and international headquarters, are at Peterborough in England. The Perkins engine range covers outputs of from 18bhp to 185bhp and includes three, four, and six-cylinder in-line and eight-cylinder 'V' configurations.

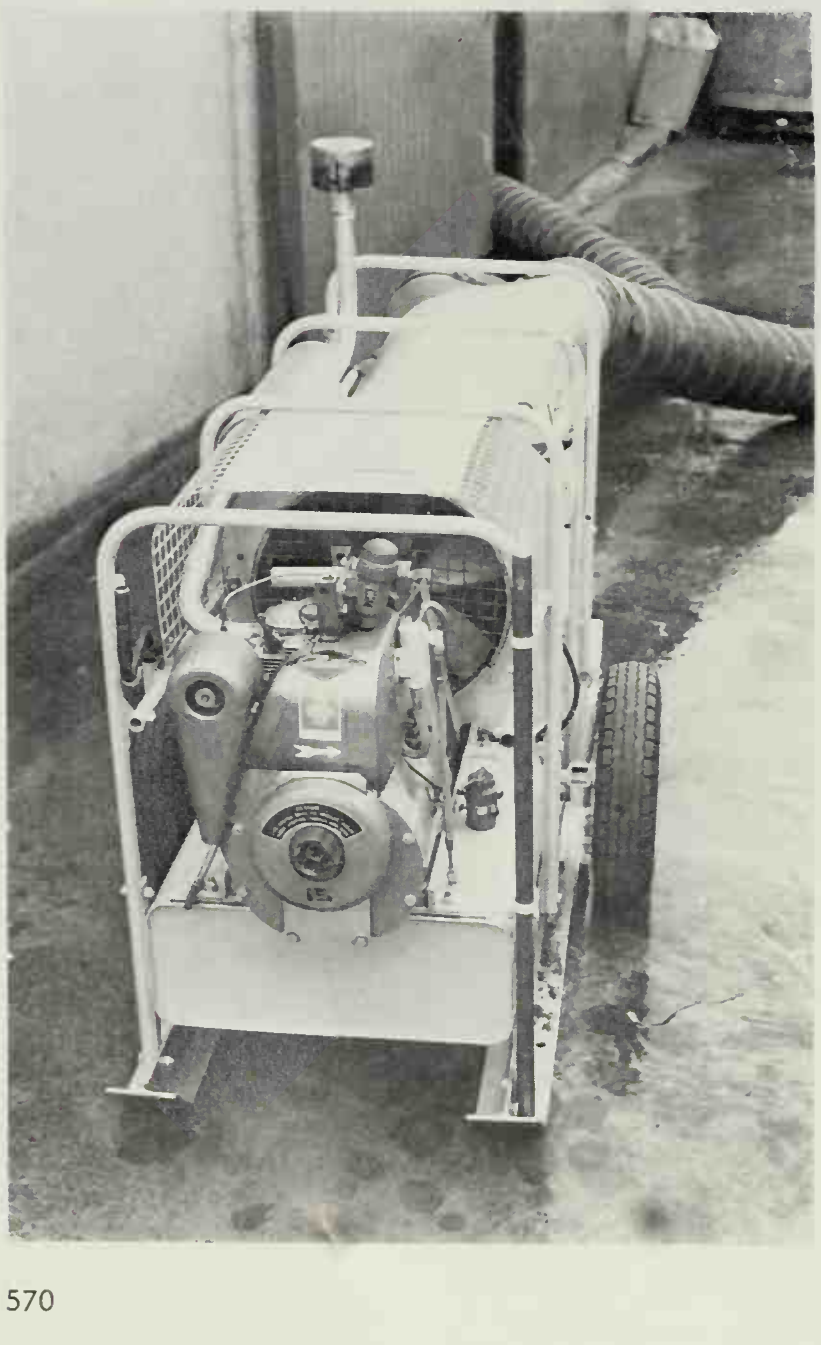
All engines are of the four-cycle, liquid-cooled and direct-injection type, except those operating above 3000rev/min where indirect injection is used. Gasoline versions of some engines are available. Specifications can be varied to meet the special requirements of altitude or climate with provision for flameproofing (non-electric starting), power-takeoff points and instrumentation.



PERKINS ENGINES LIMITED
Peterborough, PE1 5NA, England
Tel: Peterborough 67474 Cables: Perkoil Peterborough Telex Telex: 32132

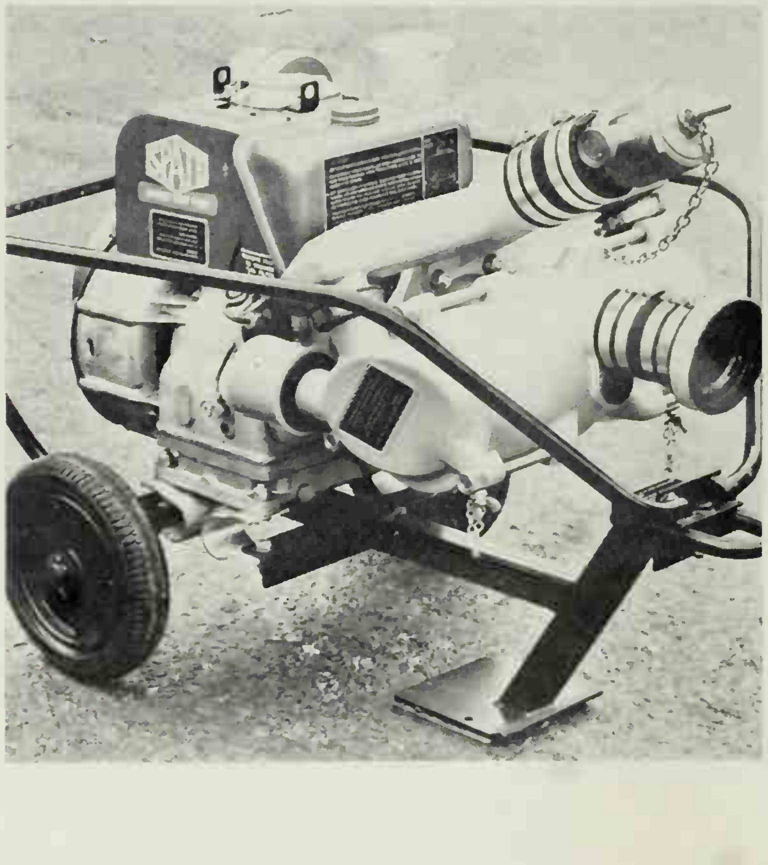


A Petter PJ4 45 bhp air-cooled diesel powering a hydraulic test rig. The equipment is standard test gear used by Royal Naval Air Stations



Left: A Petter AB1 5 bhp air-cooled diesel engine powering an oil-fired heater. The engine can be used in sub-zero temperatures

A Petter AA1 3 bhp air-cooled diesel engine used to power an induced-flow water pump in service with the Royal Navy



Diesel engines

for general applications

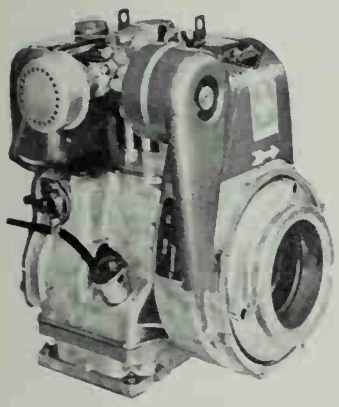
Petter industrial air and water-cooled diesel engines range from 1·5 to 45 bhp at speeds from 1000 to 3600 rev/min. They are used throughout the world to power auxiliary power units, water pumps, compressors, hoists, conveyors, loaders and other 'off-highway' equipment.

Their simple design and robust construction coupled with their versatility of drive make them ideal power units for use by armed forces. A wide range of variants has been developed to suit specialised applications.

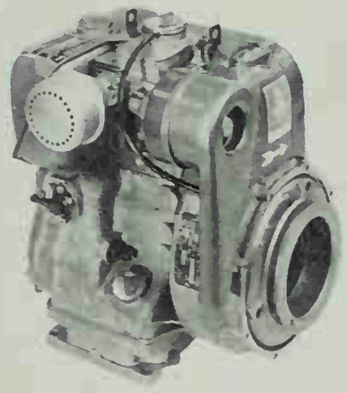
The majority of the engines can be made available with reverse rotation and up to eight methods of starting.

A world-wide network of agents with spares and service facilities is maintained by the Petter Service Division in over 156 countries. Spare parts for obsolete models are readily available, as are factory-trained service engineers to assist Petter agents and users wherever they may be.

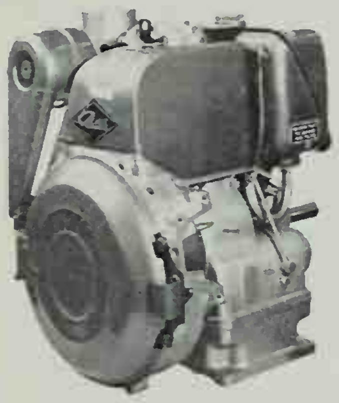
The illustrations below show only a small selection of engines from the Petter range.



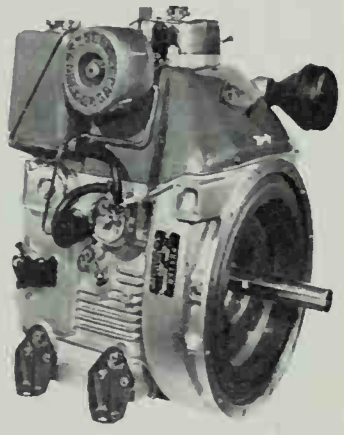
AA1, 1·5–3·5 bhp



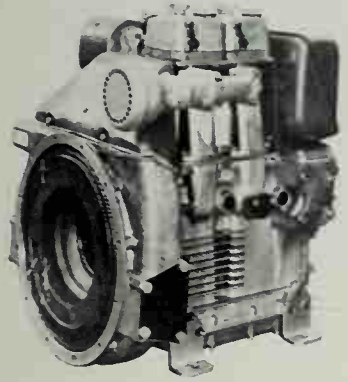
AB1 ,2·3–5·0 bhp



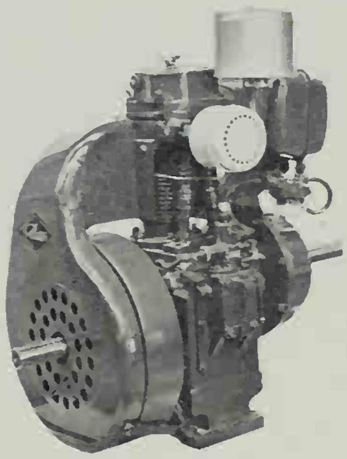
AC1, 4·2–6·5 bhp



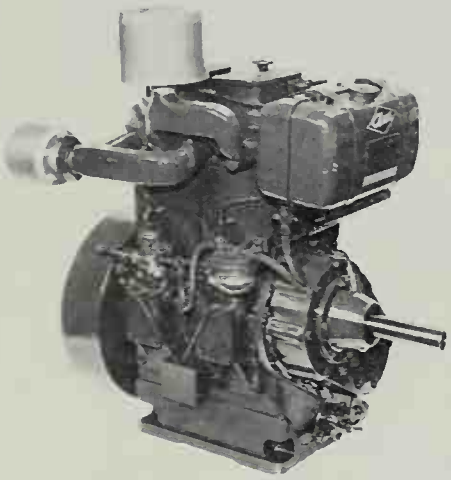
BA1, 6·75–10·0 bhp



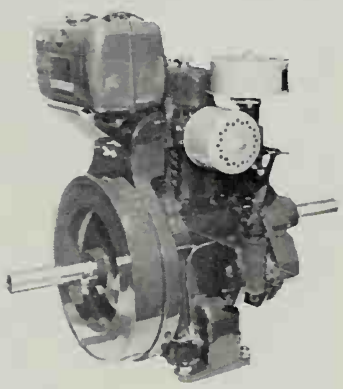
BA2, 13·5–20·0 bhp



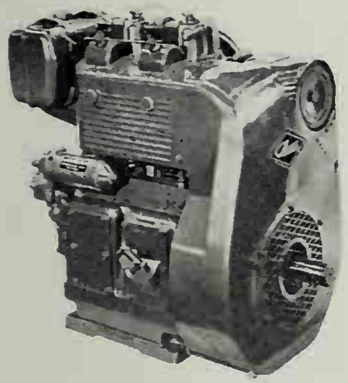
PH1/2, 4·0–16·4 bhp



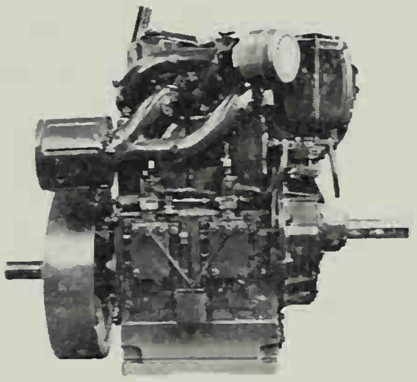
PH1/2W, 4·0–16·4 bhp



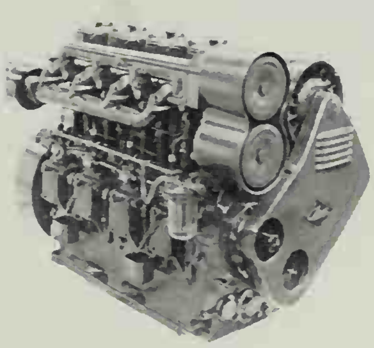
PAZ1, 1·5–3·0 bhp



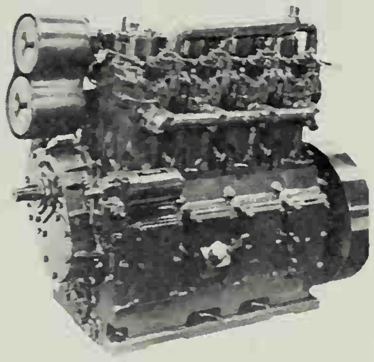
PJ1/2, 5·0–22·5 bhp



PJ1/2W, 5·0–22·5 bhp



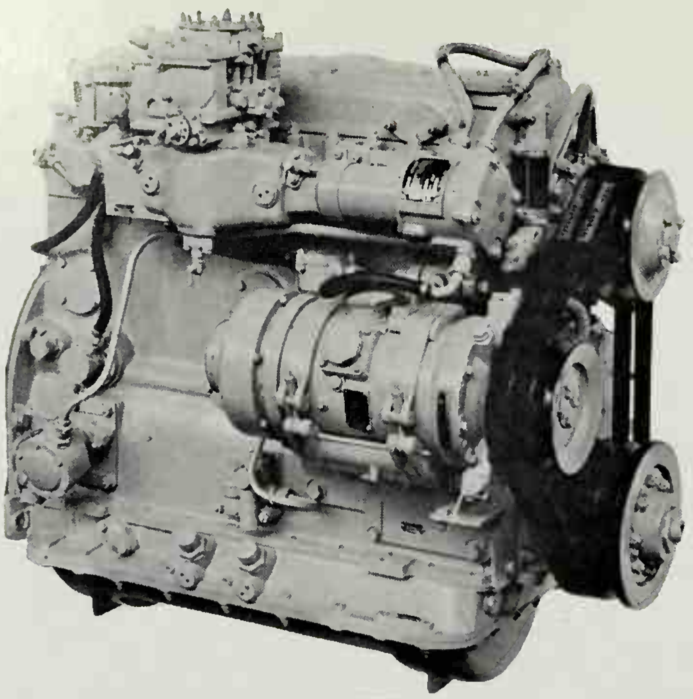
PJ3/4, 15·0–45 bhp

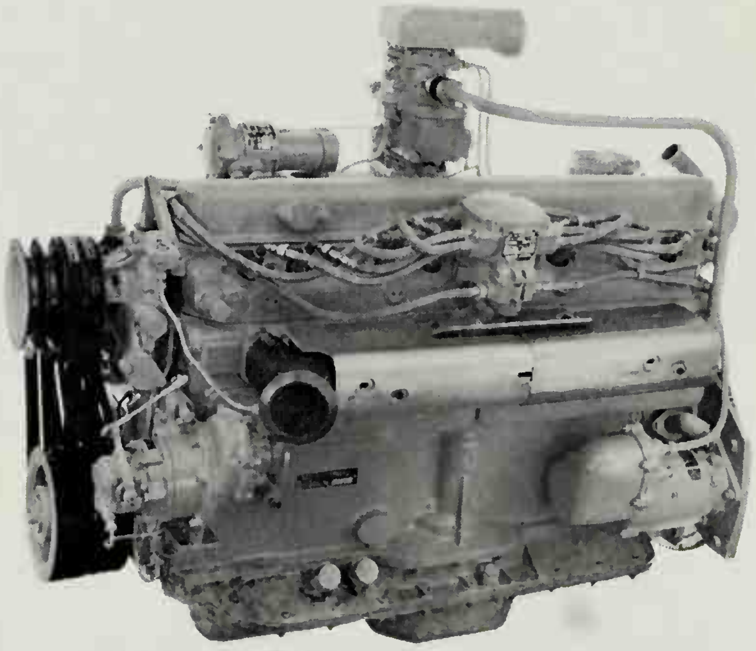


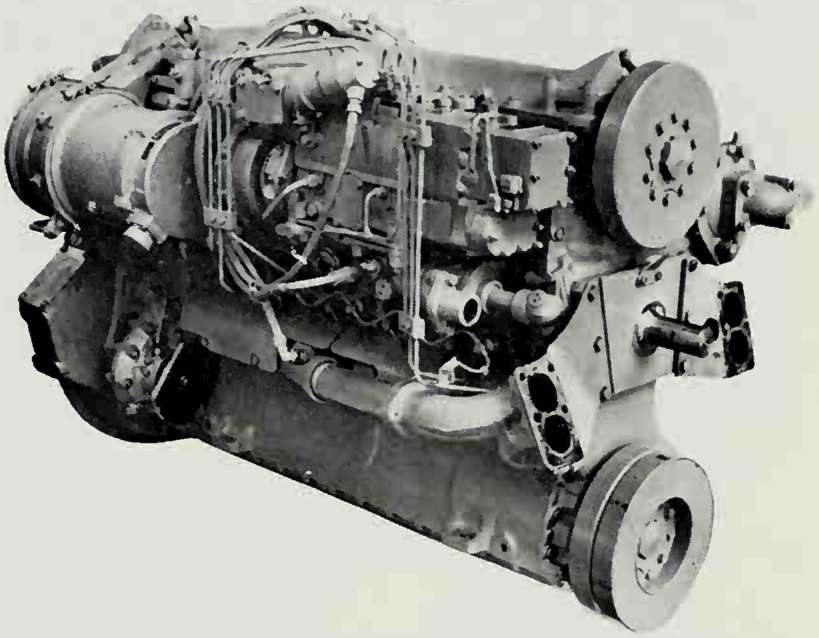
PJ3/4W, 15·0–45 bhp

A Hawker Siddeley Company

PETTERS LIMITED
Staines, Middlesex, England
Telephone: Staines 51333 Cables: Diesel Staines Telex Telex: 23871







Top: Rolls-Royce B60 six-cylinder petrol engine

Centre: Rolls-Royce B81 eight-cylinder petrol engine

Bottom: Rolls-Royce K60 multi-fuel engine

Rolls-Royce B-range petrol engines are four, six and eight-cylinder in-line units meeting power requirements of between 80 and 235bhp. Production is currently concentrated on the six and eight-cylinder versions and it is a feature of the range that several major components such as pistons, connecting rods, valve gear and bearings are common to different models.

B-range petrol engines were adopted as the standard power units for all the British Army's wheeled combat vehicles in 1948. They are also in service with 27 overseas governments. The major applications are the Daimler Ferret scout car (130bhp B60), Alvis Saladin armoured car (160bhp B80), Alvis Saracen armoured personnel carrier (160bhp B80), Alvis Stalwart high mobility load carrier (220bhp B81), and the West German HS30 armoured personnel carrier (235bhp B81). In addition B-range engines are widely used in a number of different types of general-purpose vehicle, and emergency vehicles such as airfield crash tenders (Atkinson, Thornycroft, and Alvis Salamander) and fire appliances (Dennis, ERF) where excellent performance and reliability are essential requirements.

The Rolls-Royce K60 is an advanced multi-fuel engine designed to occupy no more space than the most powerful of the B-range series. As a result, it is remarkably compact and light.

The K60 is a 6·57 litre six-cylinder, opposed-piston, compression-ignition unit developing powers up to 220bhp at 3750 output shaft rev/min. It is capable of operation on MT80 combat petrol, Avtur, Avtag, or No 1 diesel fuel.

Rolls-Royce produce the K60 and its associated transmission equipment (steering unit and licence-built Allison TX200 automatic transmission) for the British FV430 range of armoured tracked vehicles. The engine is also in full production for the Swedish S tank.

Turbocharged diesel versions of the K60 have been developed and several 275bhp K60T engines are in service. More than 500bhp has been obtained from turbocharged and intercooled K60TC engines under experimental conditions. This and the studies into multi-fuel and diesel versions of rotary piston engines exemplify the advanced research and development work undertaken by Rolls-Royce in the military engine field.

	Number of cylinders	Cubic capacity		Comp. ratio :1	Maximum power		Maximum torque			Net dry weight	
		cm³	in³		bhp	rev/min	lbf ft	kgf m	rev/min	kg	lb
Rolls-Royce B60	6	4260	260	6·4	130	4000	209	29	2500	372	820
Rolls-Royce B61	6	4887	298	7·25	168	4000	268	37	2250	369	815
Rolls-Royce B80	8	5670	346	6·4	160	3750	280	39	2250	454	1000
Rolls-Royce B81	8	6522	398	6·4	195	3750	328	45	2200	458	1010
Rolls-Royce B81	8	6522	398	6·5	220	4000	330	46	2750	458	1010
Rolls-Royce B81SV	8	6522	398	7·25	235	4000	358	50	2500	458	1010
Rolls-Royce K60	6	6570	401	eff. 15·8	220	3750*	360	50	2150*	749	1650
Rolls-Royce K60T	6	6570	401	eff. 15·8	275	3750*	425	58	2625*	816	1800

*Output shaft rev/min

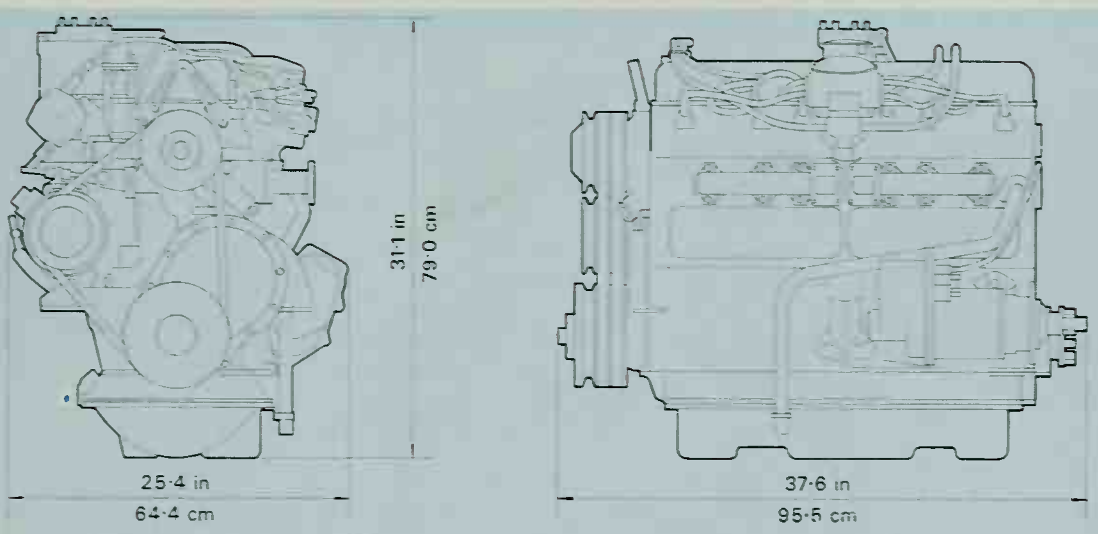
High-performance engines

for military combat vehicles

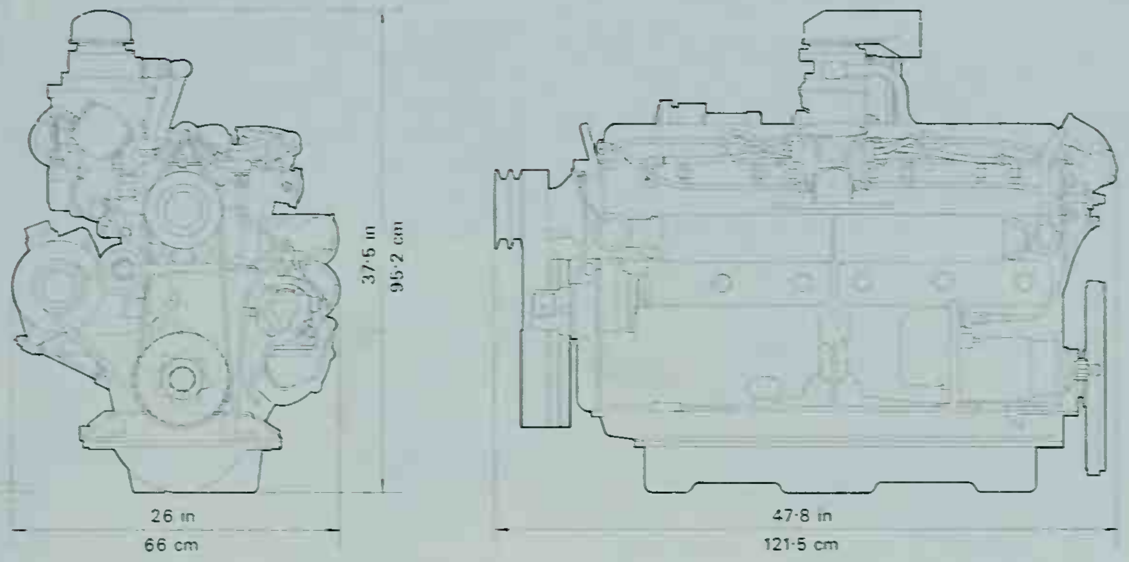
Rolls-Royce has been associated with military combat vehicles for more than 60 years and during that time has become a leading specialist in the design, development and manufacture of military engines.

Today, the company offers a range of power units which have been specifically designed for military vehicle applications. All have excellent power-to-weight and power-to-bulk ratios. All have the ability to operate at maximum power for long periods in a wide range of climatic conditions with the minimum of attention. All offer very high standards of reliability. All can be readily adapted to meet almost any specific installational requirement.

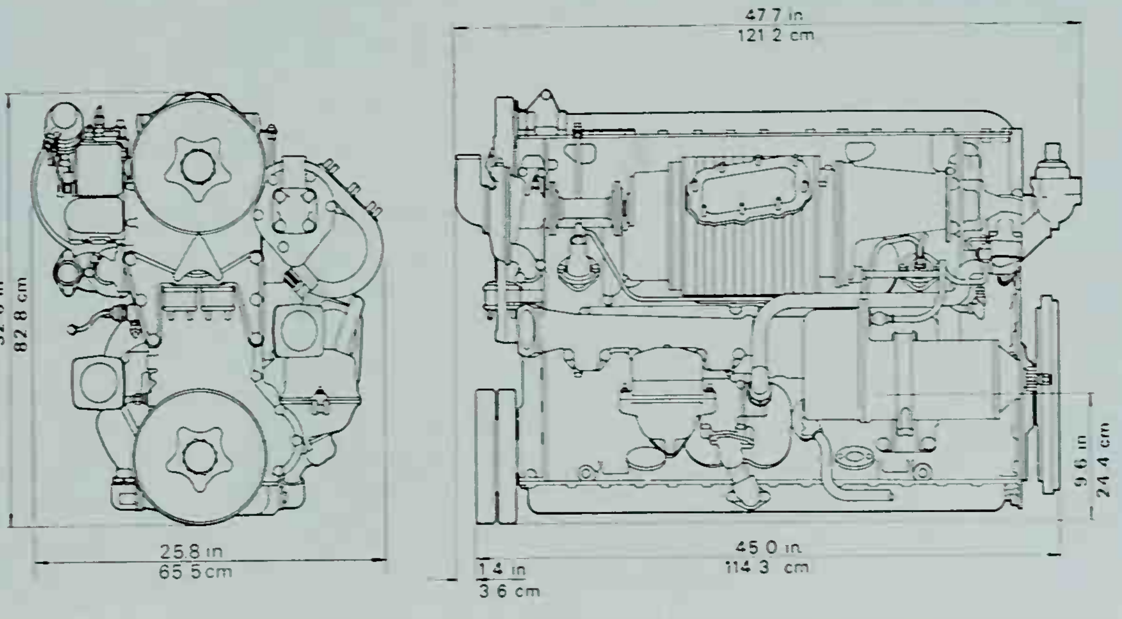
Rolls-Royce B60


31·1 in
79·0 cm
25·4 in
64·4 cm
37·6 in
95·5 cm

Rolls-Royce B81


37·5 in
95·2 cm
26 in
66 cm
47·8 in
121·5 cm

Rolls-Royce K60


47·7 in
121·2 cm
32·6 in
82·8 cm
25·8 in
65·5 cm
45·0 in
114·3 cm
1·4 in
3·6 cm
9·6 in
24·4 cm

ROLLS
ROYCE

ROLLS-ROYCE LIMITED
Motor Car Division
Crewe, Cheshire, England
Telephone: Crewe 55155 Cables: Roycru Crewe Telex: 36121

THORNYCROFT

Top: A Thornycroft tank transporter tractor unit powered by an eight-cylinder Rolls-Royce 'C' range diesel engine

Centre: *Arrakib*, a 100-foot Libyan customs patrol vessel built by John I Thornycroft & Co Ltd and powered by three Rolls-Royce 'D' range engines each of 580 bhp

Bottom: Scammell wreck recovery vehicle with a six-cylinder Rolls-Royce diesel engine

Diesel engines

for vehicles, boats, generators, compressors, etc

Rolls-Royce diesel engines operate in 115 countries throughout the world. The Oil Engine Division's products include diesel engines in various ranges producing from 100 to 750 brake horsepower, marine diesel generating sets from 70–440 kW and industrial shunting locomotives from 30–75 tons weight.

Diesel engines Four ranges of diesel engines are produced by the company, the SF65C, C and Eagle ranges of 130 mm (5⅛ in) bore and 152 mm (6 in) stroke and the D range of 168 mm (6⅝ in) bore and 184 mm (7¼ in) stroke. Engines can be cooled by radiator or heat exchanger, normally aspirated or turbocharged and are available to suit automotive, earthmoving, industrial, marine and rail traction applications.

Marine diesel generating sets Rolls-Royce engines are used in many auxiliary generating sets in service throughout the world. Their reliability has been proved over many years' service.

Locomotives Rolls-Royce manufactures four ranges of locomotives, the Vanguard, Sentinel, Steelman and Yorkshire.

Industrial and automotive engines

Model	bhp	rev/min	Length	Width	Height	Weight
SF65CN	105 to 190	1200 to 2100	1514 (59·63)	752 (29·62)	1101 (43·35)	1116 (2460)
C6NFL	117 to 210	1200 to 2100	1449 (57·07)	740 (29·12)	785 (31·30)	1133 (2499)
SF65CT	143 to 253	1200 to 2100	1511 (59·50)	762 (30·00)	1224 (48·20)	1265 (2788)
C6TFL	165 to 300	1200 to 2100	1560 (61·43)	858 (33·80)	1295 (50·97)	1185 (2613)
C8TFL	219 to 400	1200 to 2100	1797 (70·74)	836 (33·30)	1252 (49·30)	1470 (3242)
DV8N	296 to 470	1200 to 1800	1802 (70·95)	1533 (60·35)	1605 (63·20)	3493 (7700)
DV8T	377 to 582	1200 to 1800	1927 (75·90)	1533 (60·35)	1716 (67·55)	3565 (7860)
DV8TCA	485 to 750	1200 to 1800	* 2743 (108·00)	* 1699 (66·90)	* 2053 (80·80)	* 4853 (10700)
Eagle 205 (truck ratings)	127 to 205	1200 to 2100	1571 (61·85)	778·5 (30·65)	1200 (47·25)	1111 (2450)
Eagle 220 (truck ratings)	138 to 220	1200 to 2100	1571 (61·85)	778·5 (30·65)	1200 (47·25)	1111 (2450)
Eagle 260 (truck ratings)	167 to 260	1200 to 2100	1562 (61·50)	778·5 (30·65)	1200 (47·25)	1162 (2562)
Eagle 300 (truck ratings)	189 to 300	1200 to 2100	1562 (61·50)	778·5 (30·65)	1200 (47·25)	1162 (2562)

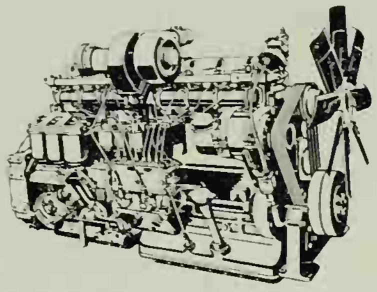
NOTE Dimensions and weights are given in millimetres and kilogrammes. Figures in brackets are the equivalent measurements in inches and pounds respectively.

*Includes radiator.

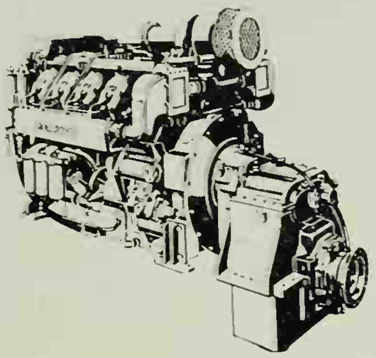
These are standard engine powers but for certain military requirements different ratings may be agreed according to application.

Marine engines

Model	bhp	rev/min	Length	Width	Height	Weight
SF65CNM	104 to 190	1200 to 2100	1495 (58·88)	930 (36·62)	1192 (46·95)	1242 (2738)
C6NFLM	117 to 210	1200 to 2100	1564 (61·58)	842 (33·17)	1147 (45·17)	1503 (3313)
SF65CTM	141 to 255	1200 to 2100	1723 (67·80)	1043 (41·10)	1229 (48·40)	1524 (3360)
C6TFLM	179 to 310	1200 to 2000	1564 (61·58)	882 (34·75)	1136 (44·73)	1524 (3360)
C8TFLM	252 to 410	1200 to 2000	1881 (74·08)	873 (34·40)	1217 (47·93)	1747 (3852)
DV8NM	290 to 455	1200 to 1800	1803 (71·00)	1509 (59·37)	1586 (62·45)	3538 (7800)
DV8TM	370 to 546	1200 to 1800	1803 (71·00)	1509 (59·37)	1622 (62·45)	3810 (8400)
DV8TCWM	450 to 685	1200 to 1800	1803 (71·00)	1509 (59·37)	1622 (62·45)	3900 (8600)



Rolls-Royce C8TFL automotive diesel engine



Rolls-Royce DV8TCWM marine diesel engine

ROLLS-ROYCE LIMITED
Oil Engine Division
Shrewsbury, Shropshire, England
Telephone: Shrewsbury 52262 Cables: Roycar Shrewsbury Telex: 35171

ROLLS ROYCE
ROLLS-ROYCE
DIESELS

Industrial and marine diesel engines

R A Lister & Company Limited, with 50 years' experience in the design and development of diesels, manufacture air-cooled and water-cooled engines within the range from 1·5 to 102 hp. Diesel engine-driven generating sets from 1·75 to 75 kVA, in single- and three-phase ac, are also built and supplied for base load and standby duties. Marine diesel engines for propulsion and auxiliary duties from 3 to 8500 bhp are marketed by a subsidiary company, Lister Blackstone Mirrlees Marine.

Lister engines are giving reliable and efficient service in a wide variety of applications throughout the world. They are supported by a first-class after-sales and spares service, provided by a network of distributors and associated companies overseas.

R A Lister & Co Ltd
Dursley, Gloucestershire, GL11 4HS, England

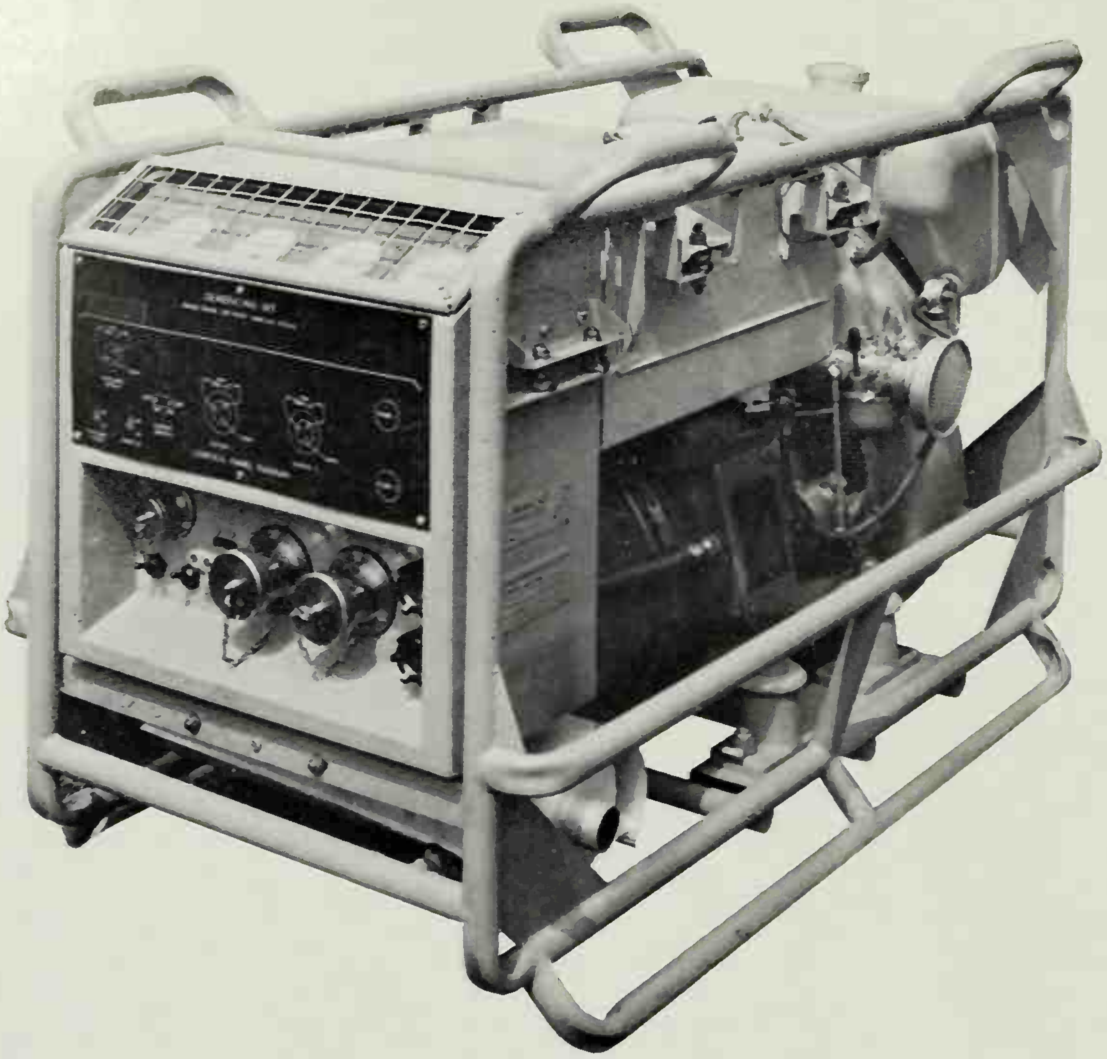
Telephone: Dursley 2371

Cables: Machinery Dursley

Telex: 43156

Section 28

Power generating equipment

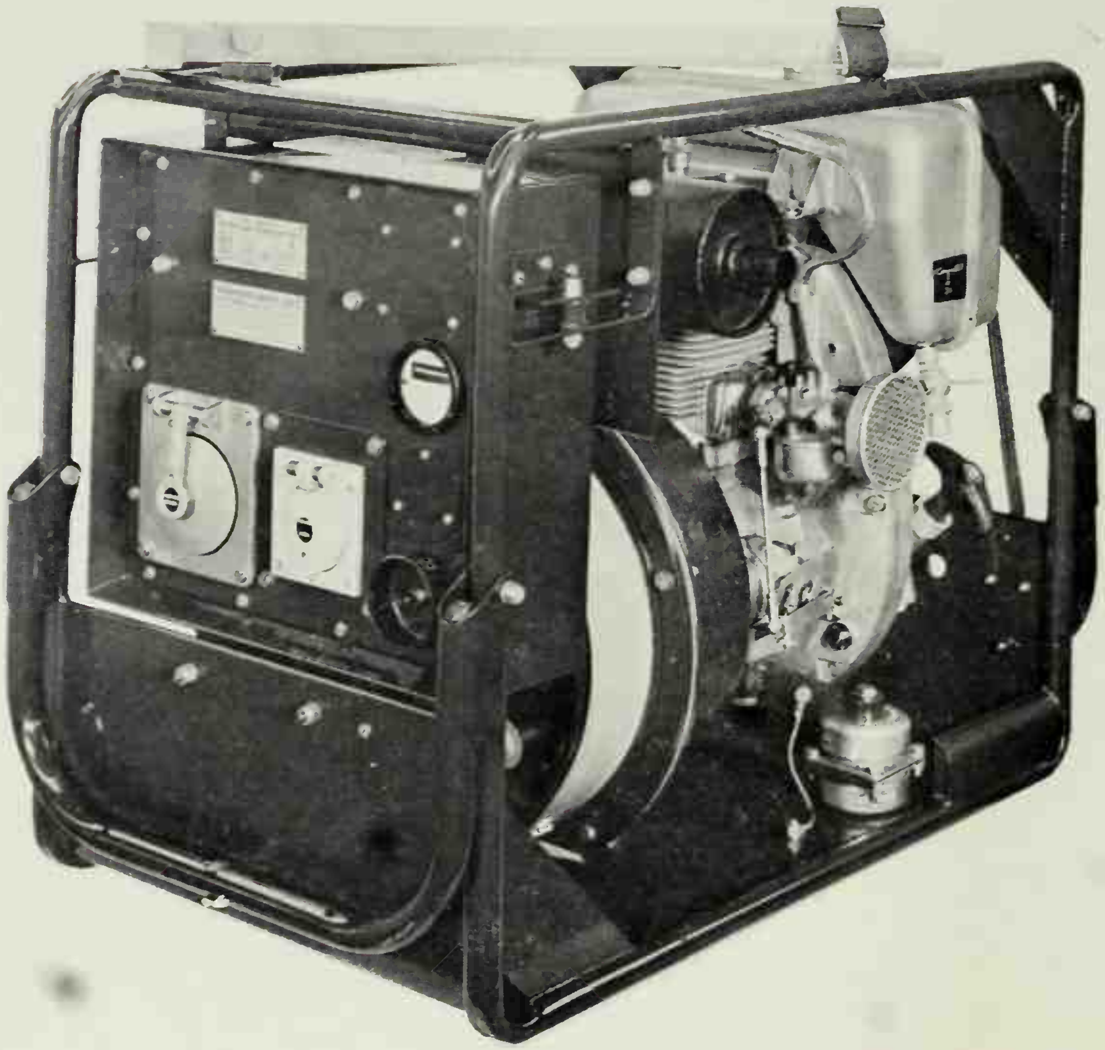


4·5 kVA, 50 Hz set

These sets have been designed to provide highly mobile sources of power for use in areas where transportation is difficult. They are light enough to be easily positioned within the working area by using the integral carrying handles, while the strong tubular steel frame, within which all the components are shock-mounted, ensures that the sets can withstand the severe loadings which may be experienced in transportation by road or air.

The performance of both sets is controlled to a closer tolerance than is usual in such lightweight generators and their reliability has been proved in extensive endurance, climatic and transportation trials. The very exacting requirements which these sets have to fulfil have been fully met without complex design features and this has reduced maintenance to a minimum. In addition the JLO L372 engine used in both sets is a very simple power unit which has a long record of excellent performance.

Each set, in its particular field, provides the optimum combination of reliability, mobility, efficiency and maintainability and the increasing variety of applications for which they have been specified indicates the high level of user confidence which has been established.



5 kVA, 400 Hz set

Power generating sets

Lightweight portable units

4·5 kVA, 50 Hz set

This is a general-purpose set which may be used as a power source for mobile workshops, lighting, communications, etc. It consists of a JLO L372 manually started two-stroke petrol engine, close-coupled to a two-pole alternator with a self-exciting rotating armature. The set produces its rated power up to an altitude equivalent of 1500 m (5000 ft) within the temperature range from –18°C to +55°C under all climatic conditions.

5 kVA, 400 Hz set

This set was originally designed to provide a lightweight power source for a wide range of 400 Hz power tools for use in remote areas and in emergency conditions such as disaster areas. The qualities necessary for successful operation in such conditions—for example mobility, reliability and robustness—make it highly suitable for other applications which similarly require readily available power, particularly since it can be transported by the smallest helicoper or road vehicle.

The generator consists of a JLO L372 manually started two-stroke petrol engine, close-coupled to a 14-pole, three-phase alternator with self-exciting rotating field. Voltage regulation is by a static exciter.

The set is designed to operate within the temperature range from –25°C to +52°C under all climatic conditions

Examples of tools which are used with this set are:
Medium breaker hammer
Rock drill hammer
Light demolition hammer
Blower
Chain saw
Circular saw
Drills up to 19 mm (¾ in) dia
Grinder

Specification

Output
Voltage: 240 V
Frequency: 50 Hz
Power: 4·5 kVA at 0·8 to 1·0 power factor

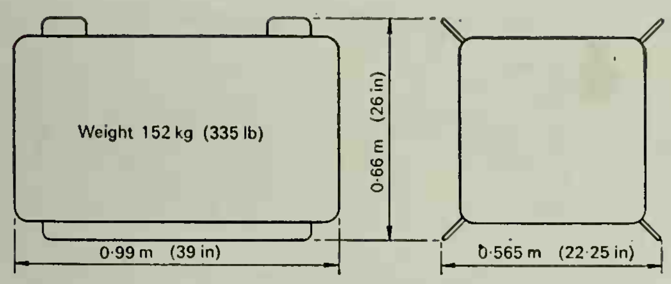
Regulation
Voltage: ±2½%
Frequency: ±2½%

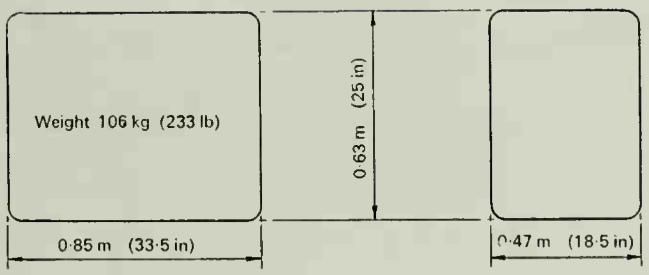
Instruments
Voltmeter, frequency meter, ammeter, hours-run meter
Fuel: 25:1 petrol/oil mixture
Fuel capacity: 31·8 litres (7 gal)
Fuel consumption: approx 4 litres/h; (0·88 gal/h) at full load
Endurance: 8 h at full load
Sockets: 2—25 A; 2—13 A; 1—5 A

Output
Voltage: 208 V
Frequency: 400 Hz
Power: 5 kVA at 0·8 to 1·0 power factor

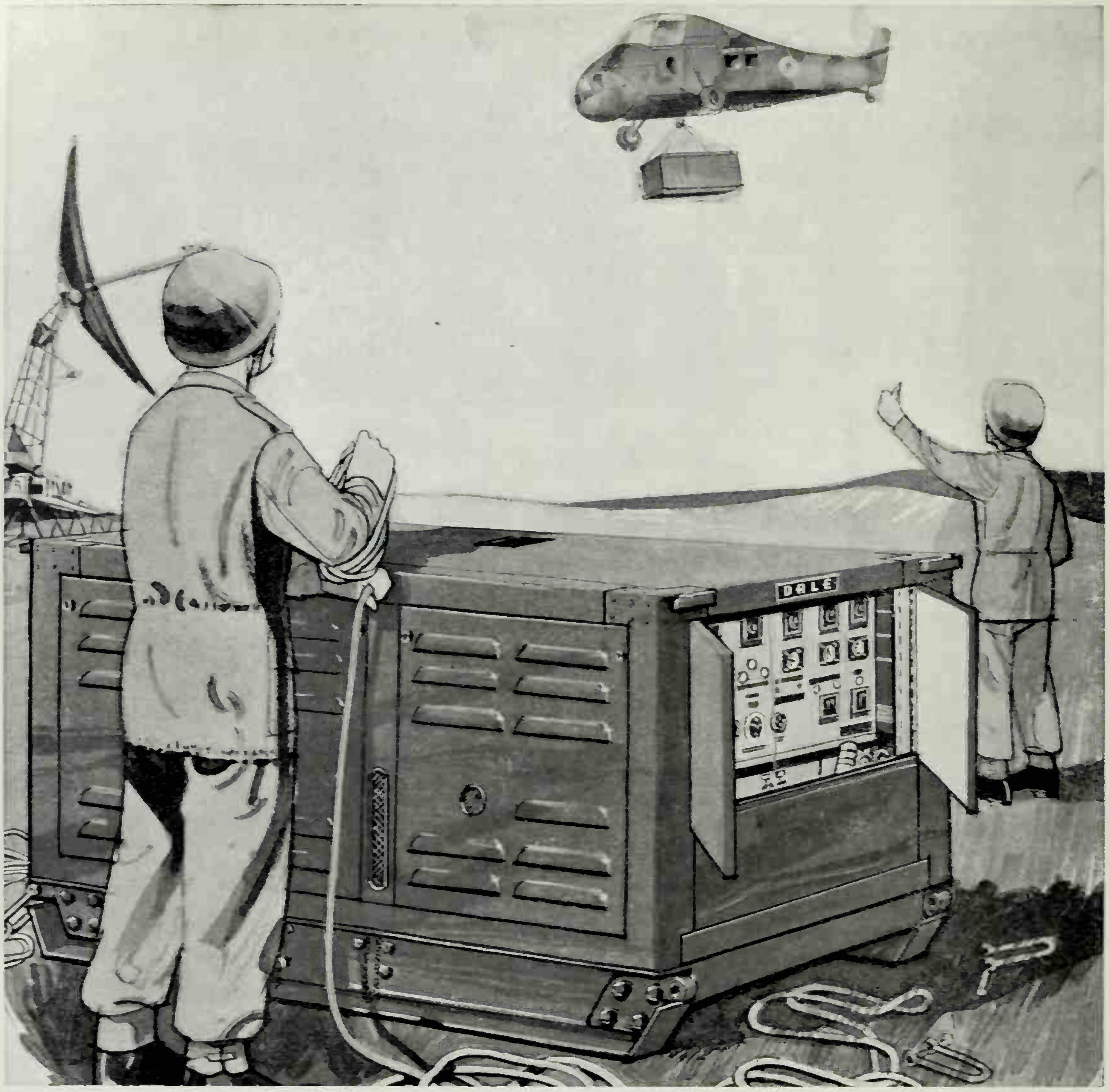
Regulation
Voltage: ±6%
Frequency: ±3·5%

Instruments
Frequency meter; hours-run meter
Fuel: 25:1 petrol/oil mixture
Fuel capacity: 9·1 litres (2 gal)
Fuel consumption: approx 4 litres/h; (0·88 gal/h) at full load
Endurance: 2·25 h at full load
Sockets: 1—25 A; 1—16 A

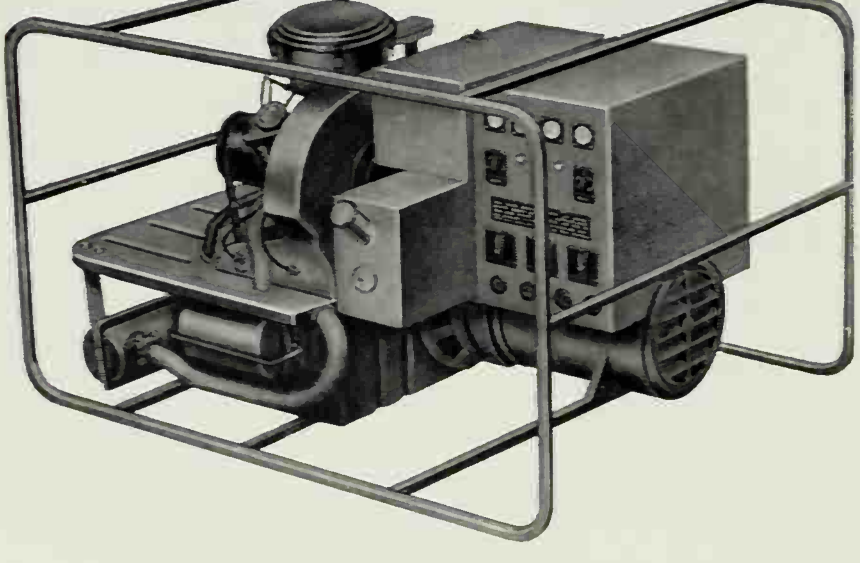




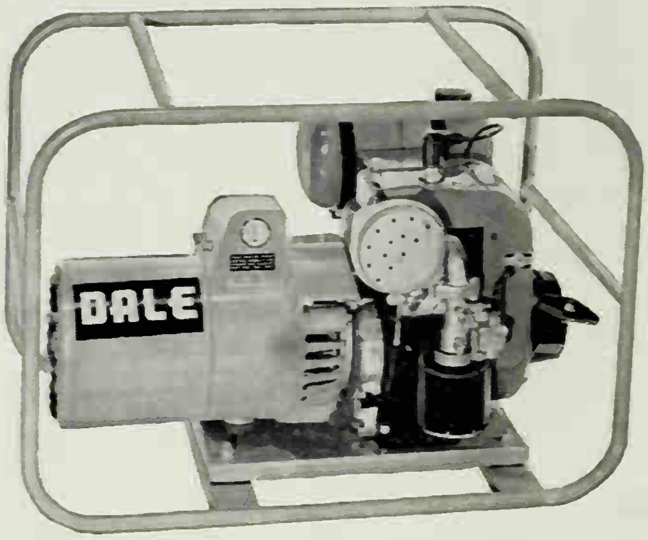
AIR-LOG LIMITED
North Lane, Aldershot, Hampshire, England
Telephone: Aldershot 24411 Cables: Airlogco Aldershot



The Dale Shield 40 kVA lightweight generating plant is completely self-contained and airportable; it can be started within minutes of being landed



The Dale 400 Hz generating plant is a rugged self-contained unit for powering military equipment anywhere



The Dale 2 kW battery charger can be carried and operated anywhere, is self-contained and of rugged construction

Power plants

Portable and transportable units

The Dale Shield range of diesel and petrol-engined powered generating equipment, covers a wide variety of portable and transportable units, which can be engineered to suit the power requirements of any particular military communications or radar system.

Three main types are illustrated with brief specifications, which may be considered typical of the basic details. The range can be extended or modified to suit particular requirements.

Plant outputs are determined by customers' requirements, each plant being engineered to suit the individual application in respect of voltage and frequency. Special cold-starting aids enable the plants to be started under any climatic conditions.

The Dale Shield range of portable units includes lightweight helicopter-transportable air-cooled units, together with skid-mounted sets, totally enclosed in weather protection canopies, providing a complete packaged unit, in which are housed all the necessary accessories such as control panel, fuel tank, etc, to enable the set to be brought into instant operation on arrival on site.

Canopies are specially designed for strength and yet to give free access to all parts of the equipment to facilitate maintenance in the field, while robust construction and careful design reduce the need for such maintenance to a minimum.

Portable lightweight 50, 60, 400 Hz sets and battery-charging sets are also described below.

A full range of Dale mobile power generating plant, complete with canopies and mounted on two- and four-wheel trailers, is described on the following pages.

40 kVA lightweight unit

This Dale lightweight generating plant has an output of 40 kVA, 36 kW at 415/240 V, 3-phase, 50 Hz under the following site conditions: from 30°C to +55°C ambient and at altitudes of up to 3600 m (8000 ft) above sea level (other standard voltages and frequencies are available). The plant is completely self-contained and incorporates lifting facilities suitable for helicopter and aircraft transportation. The engine is air-cooled, and the generator is designed to have a low harmonic content and to comply fully with all national specifications. The switchboard is fully instrumented. The unit is designed to synchronise with similar units. It has been designed to fill a particular requirement and is not an adaptation from standard equipment. The equipment is in continuous production for defence applications.

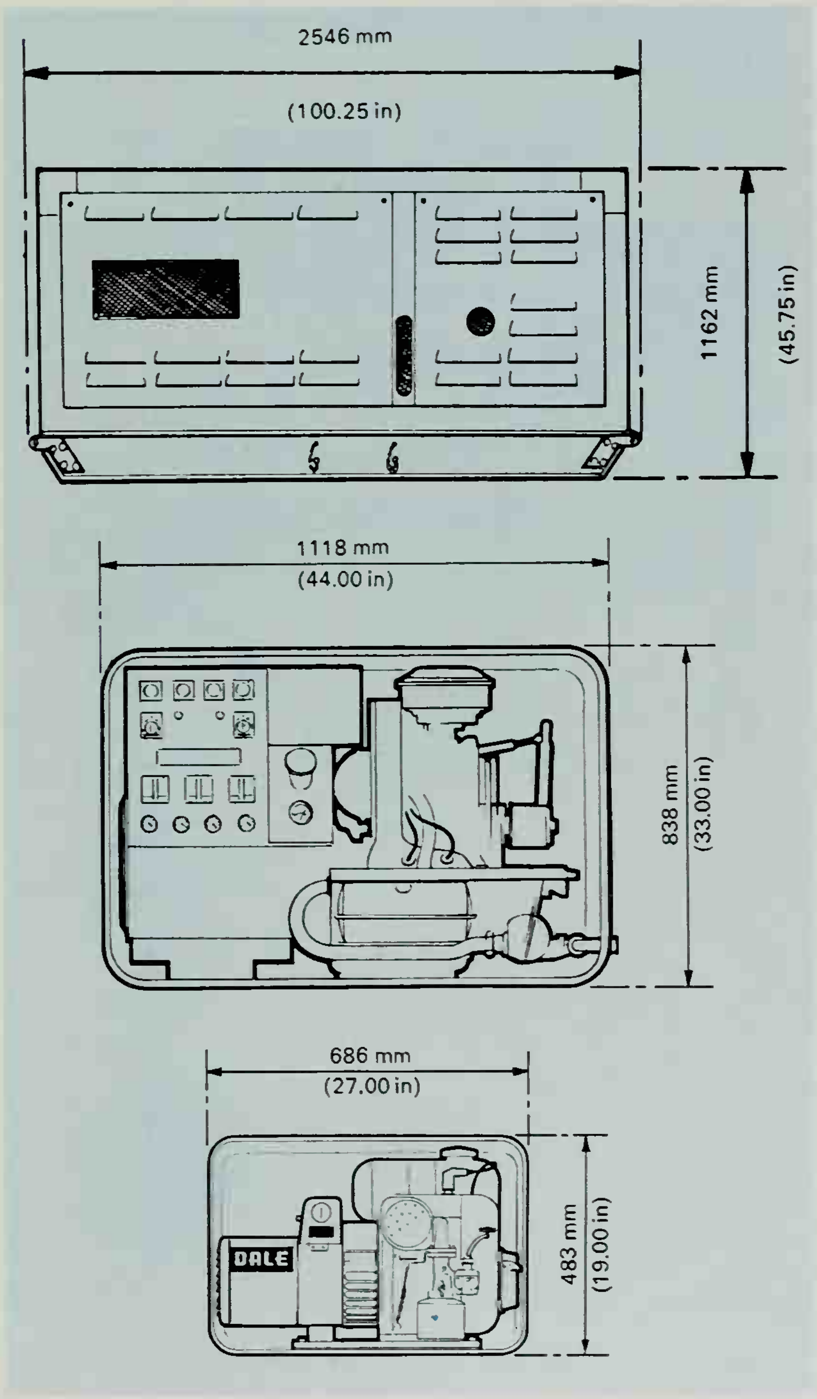
400 Hz generating plant

High-frequency units are built to meet specific requirements and are usually fitted with high-speed air-cooled gasolene engines of a popular make, modified to meet industrial conditions, such as close-range governors and flanges to connect to the generator. Units are under development with petrol injection for higher output but still retaining approximately the same weight.

The generators fitted are of a type specially designed for the application. The control panel is fully instrumented and fitted with all instructions. The unit is designed to meet arduous conditions.

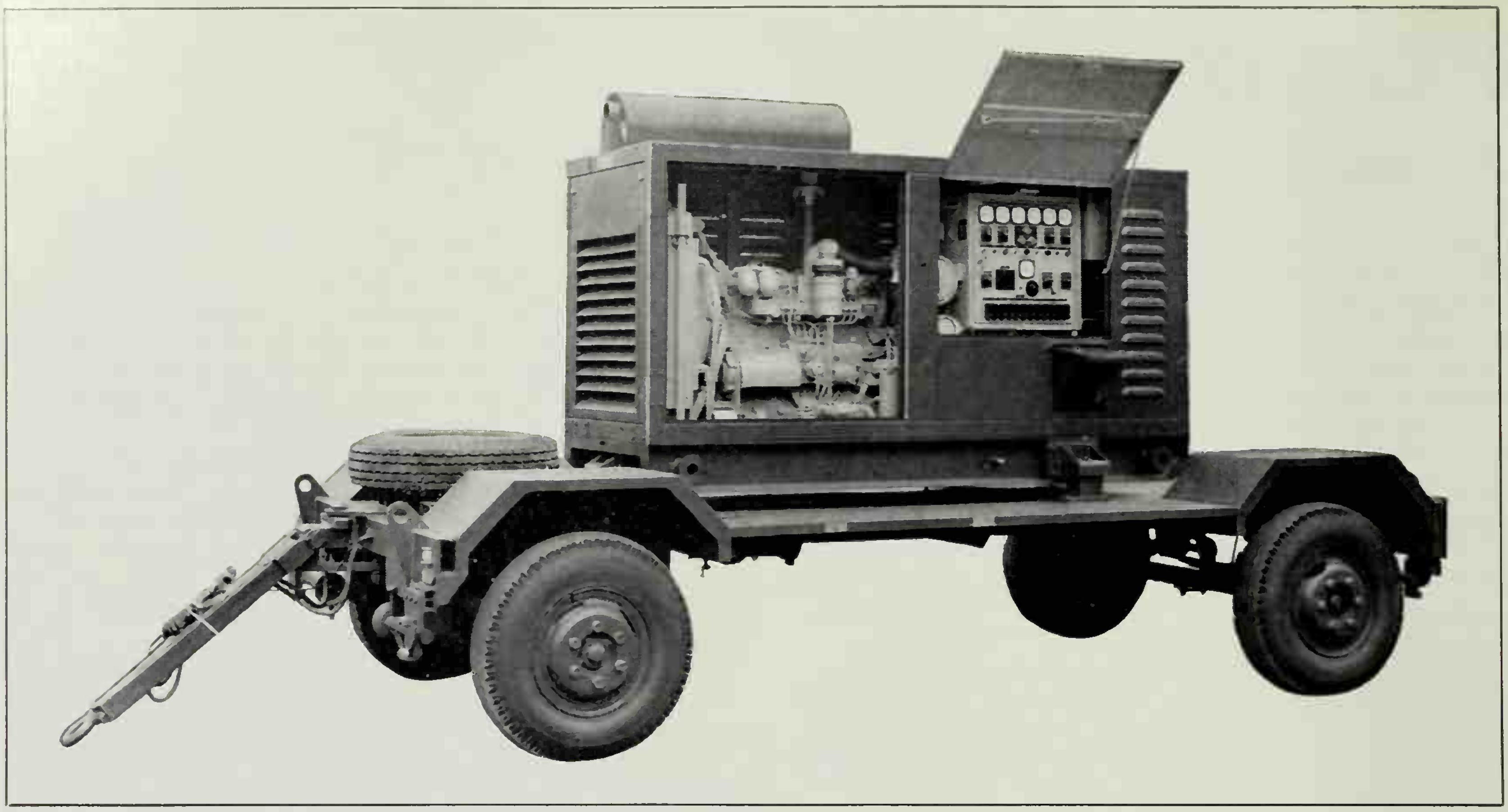
2 kW battery chargers

These units are built up to 2 kW output at 24/32 V; smaller units are available at 12/15 V. They are designed from standard commercial units but fitted into a rugged carrying frame. Suitable for base camp operations and maintenance, usually fitted with popular air-cooled gasolene engines of high quality—easily transportable by hand.

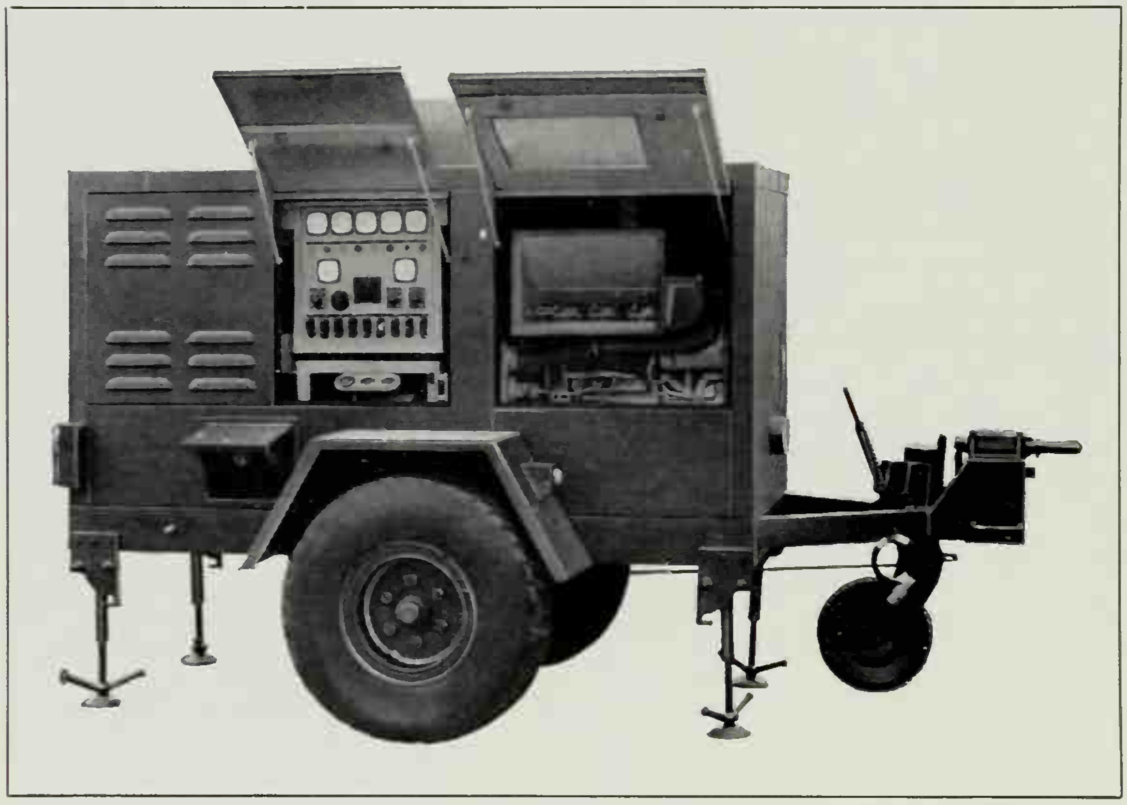


DALE ELECTRIC OF GREAT BRITAIN LTD
Electricity Buildings, Filey, Yorkshire, England
Telephone: Filey 2011 Cables: Dalectric Filey Telex 52163

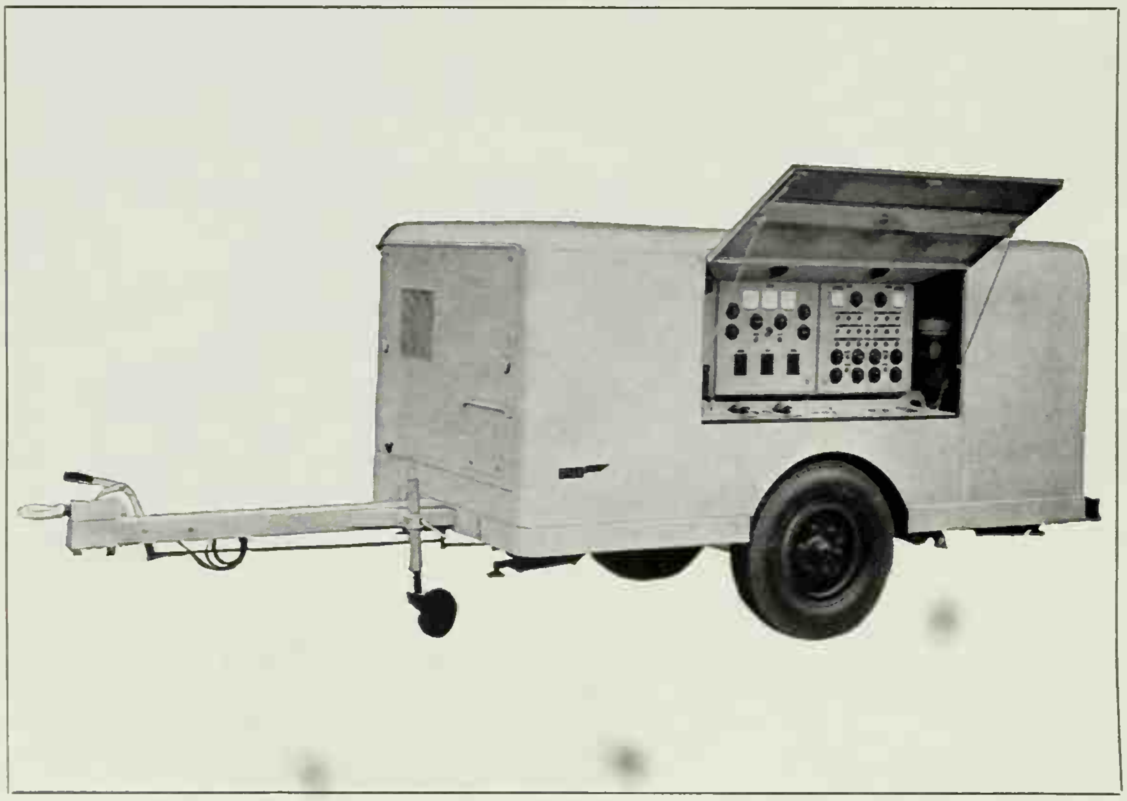
DALE



Dale 27·5 kVA power generating set mounted on a four-wheeled military-type trailer



Dale 15 kVA high-speed power generating set mounted on two-wheeled trailer



Dale 10 kVA trailer-mounted dual power generating set with two engines arranged to alternate in continuous duty

Mobile power plants

Trailer-mounted diesel units

Dale mobile generating plants for military use are specially designed to give a continuously satisfactory performance under the arduous conditions experienced in military and other service arenas.

In the civilian field, Dale mobile generating equipment has earned for itself a reputation for quality and reliability of performance, won by producing equipment in close liaison with the engineers of electricity authorities, who required mobile units for emergency standby duties, and with telecommunications equipment companies requiring mobile power units, for communications and radar equipments.

The same forethought has been given to the design of the Dale Shield range of military power generating equipment. Leading authorities in this field have been consulted and, where practical, their ideas and requirements have been incorporated in the design.

Throughout every stage of their manufacture, the plants are built by fully qualified engineers, using the finest materials and component accessories available in Britain today.

Finally, they are subjected to an exhaustive testing of the engine, generator and control gear, working together as a single unit, to ensure that the complete equipment, including the trailer, meet the required specifications.

The Dale Shield range mobile units include heavy-duty trailer-mounted water-cooled sets, purpose-built plants incorporating detachable running gear, and conventional two-wheel military trailer sets.

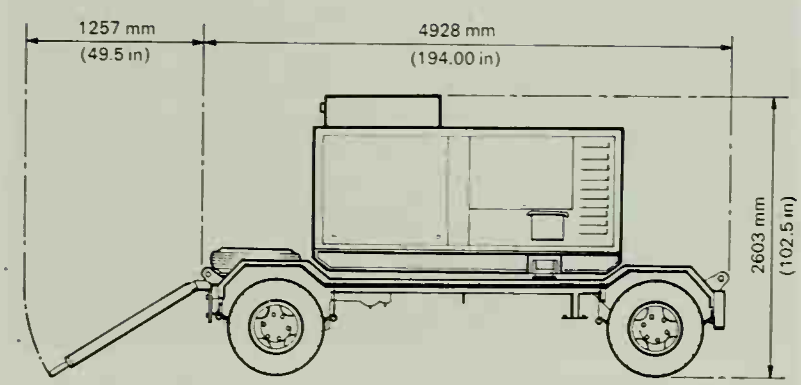
A comprehensive range of Dale lightweight portable diesel and petrol engine-powered generating sets, including battery-charging equipment is described in the preceding pages.

27·5 kVA four-wheeled trailer-mounted sets

These units are fitted with a heavy-duty radiator-cooled diesel engine, which are monobloc-coupled to the alternator, having a standard voltage and frequency. The generator is designed to have a low harmonic content and is suitable for operating defence radar equipment. The engine can operate under arduous conditions from −30°C to +55°C ambient and at altitudes up to 3600 m (8000 ft) above sea level. The plant is absolutely complete with fully instrumented control panel, full instructions, two methods of starting—electric and hydraulic—fuel tank, batteries and silencer. The complete unit is enclosed in a weatherproof rustproof canopy with convenient access doors.

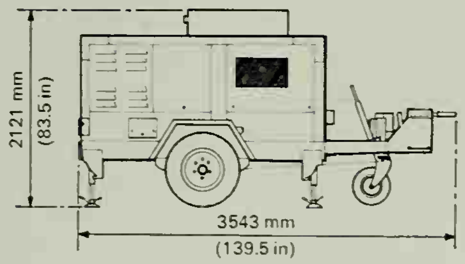
The complete unit is mounted on anti-vibration mountings on a heavy rugged four-wheeled military-type trailer. The trailer is fitted with Ackerman steering and has a two-line compressed-air braking system. Turntable steering can be offered as an alternative. The trailer also incorporates stabilising jacks with elephant feet fitted at each corner. A NATO towing hitch is fitted. The generating set itself is fitted with lifting bollards, so that, if required, it can be removed from the trailer as a complete unit and can be left on the site. The trailer itself is also fitted with lifting bollards for easy cranage.

As usual with Dale equipment, it has been designed in conjunction with the personnel who use this type of equipment.



15 kVA high-speed trailer-mounted sets

These units are smaller than the 27·5 kVA counterpart, and are fitted with either water-cooled or air-cooled diesel engines. The units are built on two-wheeled chassis with over-run brakes and front jockey wheel. They are capable of being towed at high speed in all conditions. Stabilising jacks are also fitted and sand tyres may be fitted as an optional extra. The units are capable of operating in any part of the world under the most arduous conditions. Colour schemes are to the clients' requirements.

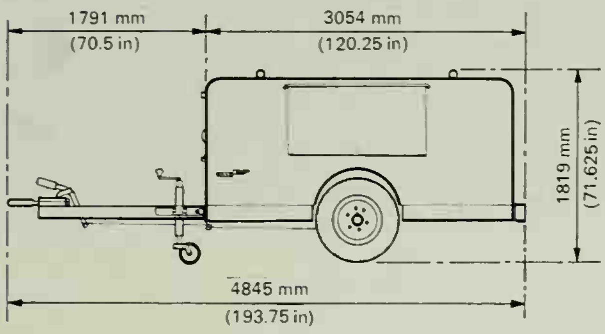


10 kVA trailer-mounted dual sets

These units are specifically designed to meet the requirements of a defence system employing generating sets on a continuous automatic cycle. They are normally built up to 10 kVA at any standard voltage and frequency. They comprise of two generating sets mounted in one trailer. The engines are normally of the air-cooled type capable of starting under most conditions: they are arranged to be fully automatic by way of duty cycling: No 1 unit runs for a prescribed time and 5 minutes before this time has expired No. 2 unit starts and, provided it functions properly, the supply changes over automatically with minimum delay. No 1 set continues to run for a few minutes and then close down, ready for the next sequence of operation. If one unit should fail through lack of oil or high temperature, the other set starts up, takes over the load immediately and submits a warning. Long-running lubricating facilities are available.

The control panel, which controls both sets, is fully instrumented and automatic. All protection devices are fitted.

The trailer is of the high-speed type and is fitted to meet international regulations as far as braking and lighting are concerned. A large fuel tank is mounted into the trailer, with filling facilities, both automatic and manual. A spare wheel is fitted.



These units have been developed in situations which demand this type of equipment and, like the whole of the Dale Shield range of power plants, are designed especially to meet the arduous conditions to which they have to be subjected because of their application.

DALE ELECTRIC OF GREAT BRITAIN LTD
Electricity Buildings, Filey, Yorkshire, England
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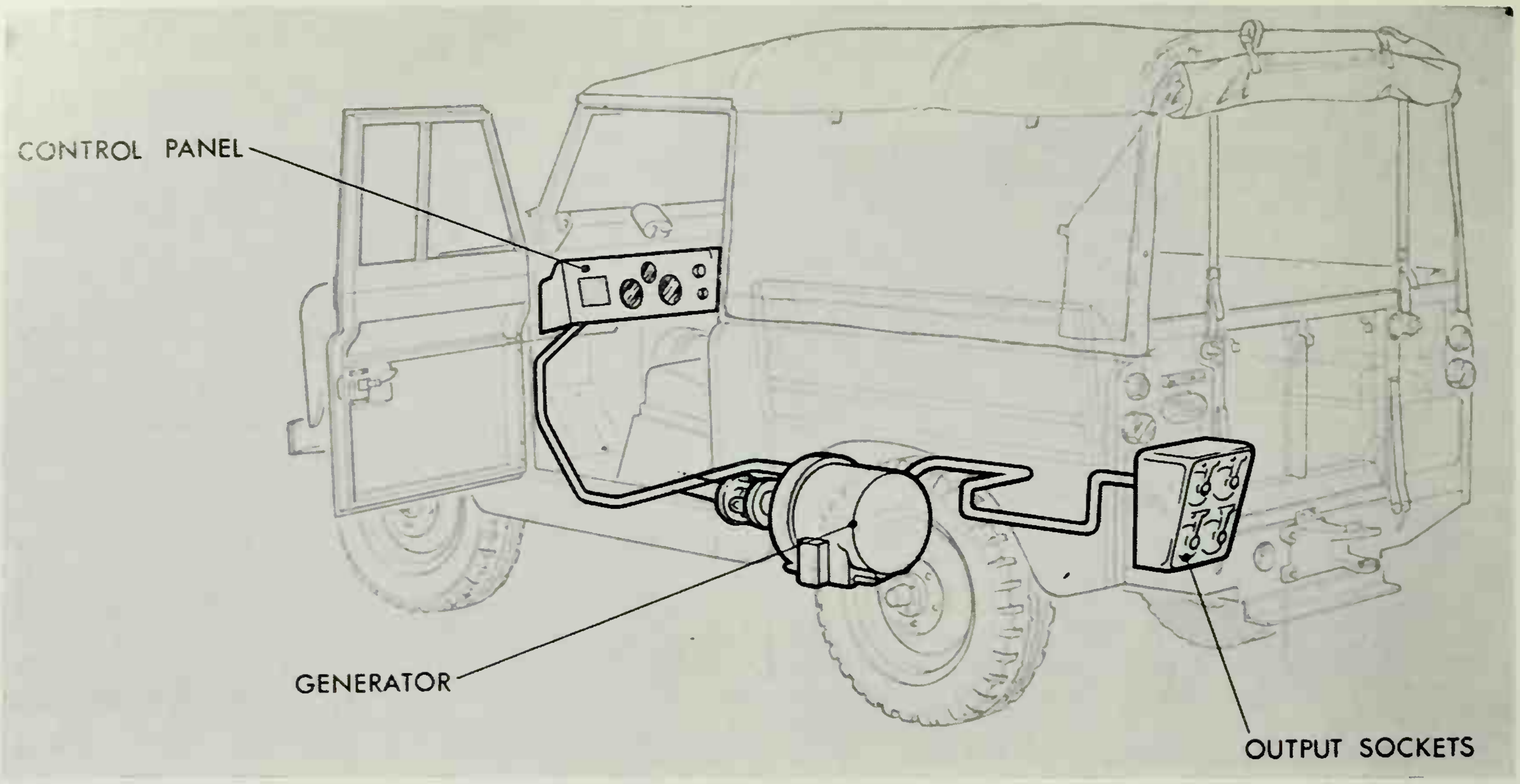


The Rotax Special Products Group 400Hz generating system provides a mobile power source for the operation of a wide range of equipment and can be installed on most vehicles employed by the armed services. In a typical system, the generator is mounted on a chassis cross member beneath the vehicle floor and is driven from the engine via a power take-off adaptor. As the freight space, ground clearance and manoeuvrability of the vehicle are unaffected, it can transport both men and tools to any site within its designed cross-country capability. Similarly, the generator and its associated control and protection equipment will operate under any environmental or climatic condition in which the vehicle may be employed. When the generator is not required the vehicle may be operated in its normal role.

The generating set is simple to use and can operate at full power within one minute of the vehicle coming to rest by engaging the power take-off and setting the engine governor control. A three-position switch on the control panel is operated to connect the supply to the outlet sockets mounted at the rear of the vehicle.

Applications

Mobile workshop: Welding unit, drills, grinders, nibblers, shears, hacksaw

Construction: Rock drill, breaker hammer, floodlighting, immersible pumps, concrete vibrators

Wood cutting: Chain saw, circular saw

Crash rescue: Cutting discs, shears, nibbler

Power supplies: Communications, operation and check-out of radar and instrument systems.

The following tools can be operated simultaneously:

three chain saws; five portable saws; one chain saw and three portable saws; two chain saws and two portable saws; three hand grinders; seven rock breakers; five earth borers; three immersible pumps; two welding sets; ten concrete vibrators.

Many permutations of the above, including a large number of smaller tools, ie hand drills, shears, etc. are also possible.

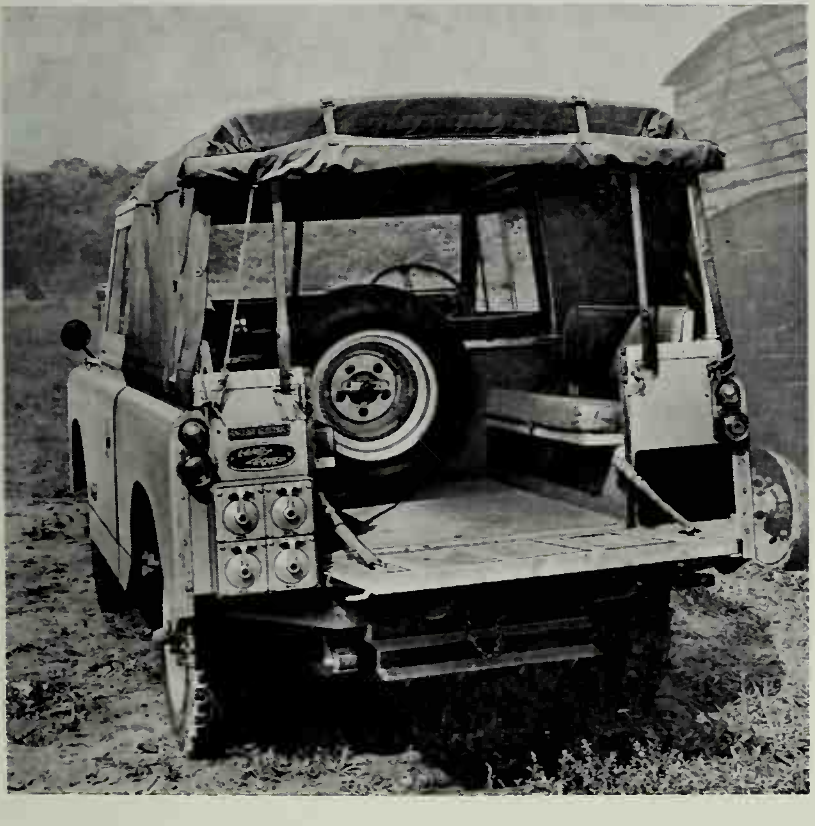
15kVA generating system

for power take-off vehicle installation

The Rotax Special Products Group (formerly English Electric) vehicle-mounted generating system is approved by The Rover Co Ltd for use on the Land Rover. It can be installed on any vehicle which has power take-off facilities. When installed, the system does not in any way affect the freight space, ground clearance or manoeuvrability of the host vehicle. The result is a mobile power source which can transport both men and tools to any site within the vehicle's original design capability.

The system is designed for the use of high-frequency, high-power tools and can be fully operational within one minute of the vehicle coming to rest.

It is simple to use and should not require maintenance during the useful life of the vehicle.



Specification

Output: 15kVA 200V (115V to earth) 3-phase 400Hz at 0·8pf lagging supplied to four 16A outlet sockets mounted at the rear of the vehicle

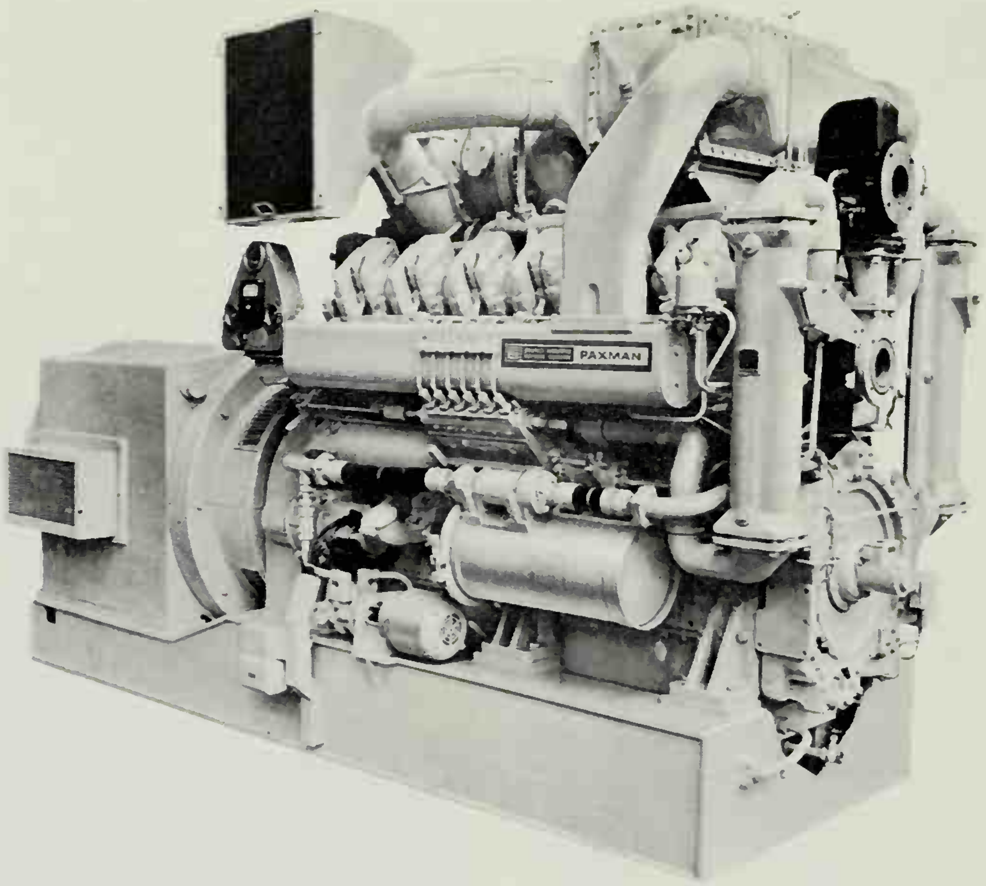
Generator: Two-stage brushless air-cooled self-excited generator

Control: Voltage regulator, semi-conductor type mounted on the generator control panel on the vehicle dash

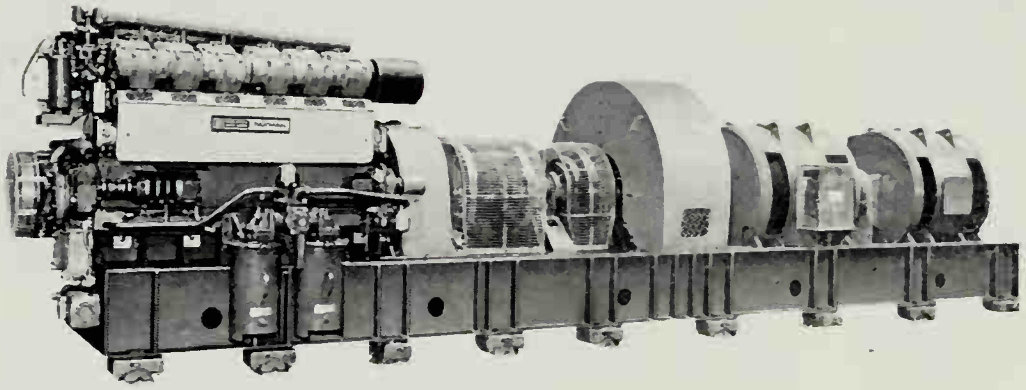
Protection: Thermal overload circuit breaker in outlet socket assembly. Earth leakage trip circuit in control panel removes generator excitation if leakage to earth occurs

Installation and servicing: The system can be installed in one day from a kit of parts using tools available in any garage. Generator and regulator should not require servicing during useful life of vehicle

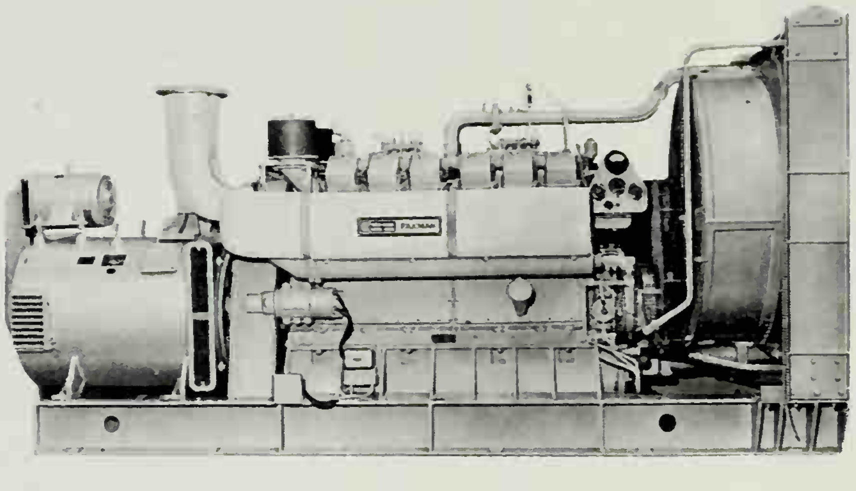
ROTAX LIMITED
Special Products Group—Aircraft Equipment Division
Phoenix Works, Bradford 3, Yorkshire, England
Telephone: Bradford 65271
Cables: Rodynalite Bradford Telex   Telex: 51336



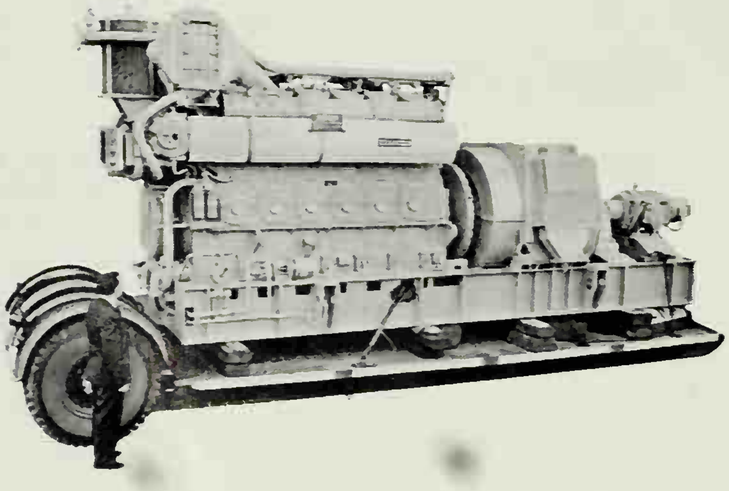
A 1000kW stand-by generating set powered by a Paxman Ventura engine



A typical example of a 'no-break' alternator set manufactured by the Paxman Engine Division. The unit is powered by a 12-cylinder RPH engine running at 1500 rev/min and produces 350kW



A Paxman generating set powered by a 12-cylinder YHX engine producing 450kW



A mains-failure automatic start set powered by a 12-cylinder Paxman engine producing 1100kW. The set is shown here trailer-mounted for transport, clearly illustrating its compact design

Power generating sets

Stationary diesel units

The Paxman range of diesel engines for all shore-based requirements includes the 178mm (7in) bore range (RPH and YH) and Ventura engines with outputs ranging from 100 to 2035bhp (100–1440kW).

Stationary generating sets are designed for instant use as base-load generating plants or for automatic standby duties in the event of mains supply or grid failure. The sets incorporate vee-form diesels of Paxman design, combining the advantages of accessibility, ease of maintenance and minimum weight; they are convenient for installation in restricted compartments. Details of skid- and trailer-mounted transportable and mobile diesel generating sets are given elsewhere in this volume.

Soundproof hoods and resilient mountings can be supplied where noise or vibrations may interfere with adjacent activities.

Fully automated controls are available, including engine-protection devices. Remote controls obviate the necessity of full-time attendants. Mains-failure, automatic start and 'no-break' sets are widely employed to ensure continuity of supply, particularly in operations rooms, communication centres and for airfield lighting. Special governors are available for sets requiring very accurate speed control.

Typical outputs, dimensions and weights

Engine	Continuous rating rev/min						Standby rating rev/min						Overall dimensions				Approx wght	
	1500		1200		1000		1500		1200		1000		Length		Width		Dry	
	bhp	app. kW	bhp	app. kW	bhp	app. kW	bhp	app. kW	bhp	app. kW	bhp	app. kW	mm	in	mm	in	kg	lb
4RPH	160	110	153	101	133	88	176	121	168	111	146	97	1245	49	1295	51	2260	5000
4RPHX	203	138	192	130	173	117	223	154	211	143	190	127	1270	50	1320	52	2330	5120
4RPHC	250	171	248	167	232	156	275	188	273	184	256	171	1270	50	1295	51	2370	5220
6RPH	274	188	240	162	200	135	301	207	264	178	220	149	1475	58	1295	51	2790	6150
6RPHX	304	209	288	197	260	178	334	222	317	217	286	196	1525	60	1400	55	2840	6270
6RPHC	375	260	371	255	348	240	413	286	409	280	383	264	1525	60	1450	57	2880	6370
8RPH	366	255	320	218	267	180	403	281	352	240	294	198	1780	70	1295	51	3290	7250
8RPHX	406	284	384	264	346	238	447	312	422	290	381	262	1855	73	1400	55	3380	7430
8RPHC	500	348	496	342	464	324	550	383	546	376	511	356	1855	73	1450	57	3420	7530
12RPH	562	393	480	330	400	276	618	432	528	363	440	303	2310	91	1295	51	4540	10 000
12RPHX	610	423	576	398	520	358	670	465	634	438	572	374	2540	100	1500	59	4630	10 200
12RPHC	750	517	743	512	696	480	825	570	820	563	766	528	2540	100	1500	59	4700	10 350
12YHX	900	630	806	555	700	482	990	693	803	559	715	495	2540	100	1570	62	4980	10 970
12YHC	1050	735	900	625	800	555	1160	815	1000	700	800	610	2540	100	1570	62	5060	11 150
6YJX	550	380	500	345	450	310	605	418	550	380	494	341	1625	64	1420	56	3660	8050
6YJC	700	485	600	414	525	363	770	534	660	455	578	400	1625	64	1420	56	3750	8275
8YJX	750	520	670	465	600	415	825	572	737	512	660	456	1700	67	1345	53	4250	9350
8YJC	925	640	800	555	700	485	1018	705	880	610	770	534	1700	67	1345	53	4360	9600
12YJX	1150	810	1000	700	900	630	1265	891	1100	770	990	693	2060	81	1345	53	5180	11 400
12YJC	1400	985	1200	845	1050	742	1540	1084	1320	930	1155	816	2060	81	1345	53	5460	12 025
16YJX	1530	1080	1350	952	1200	850	1683	1188	1485	1047	1320	930	2590	102	1345	53	6950	15 300
16YJC	1850	1310	1600	1135	1400	985	2035	1440	1760	1250	1540	1084	2590	102	1345	53	7220	15 900

Standby rating is the power available from the engine for intermittent and standby duty

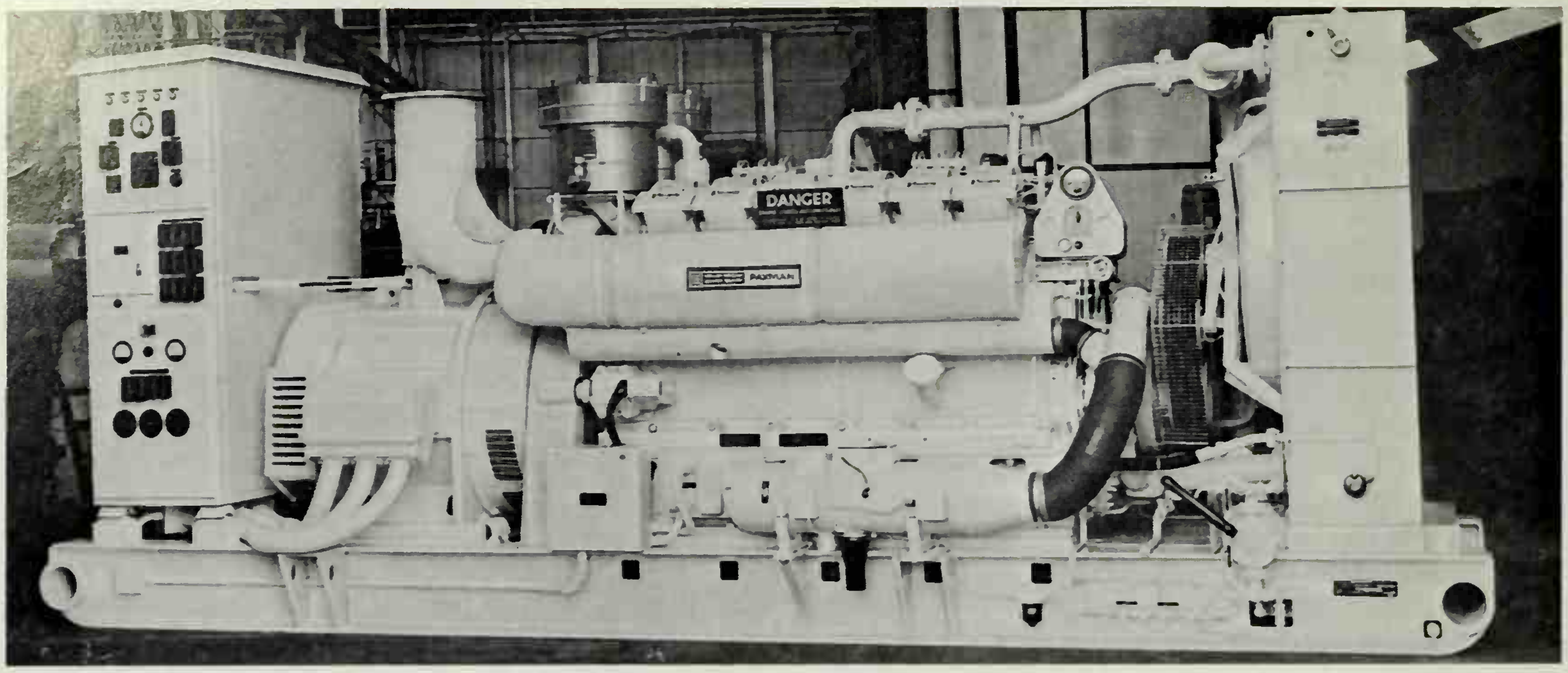
Continuous rating is the power available for base load duty

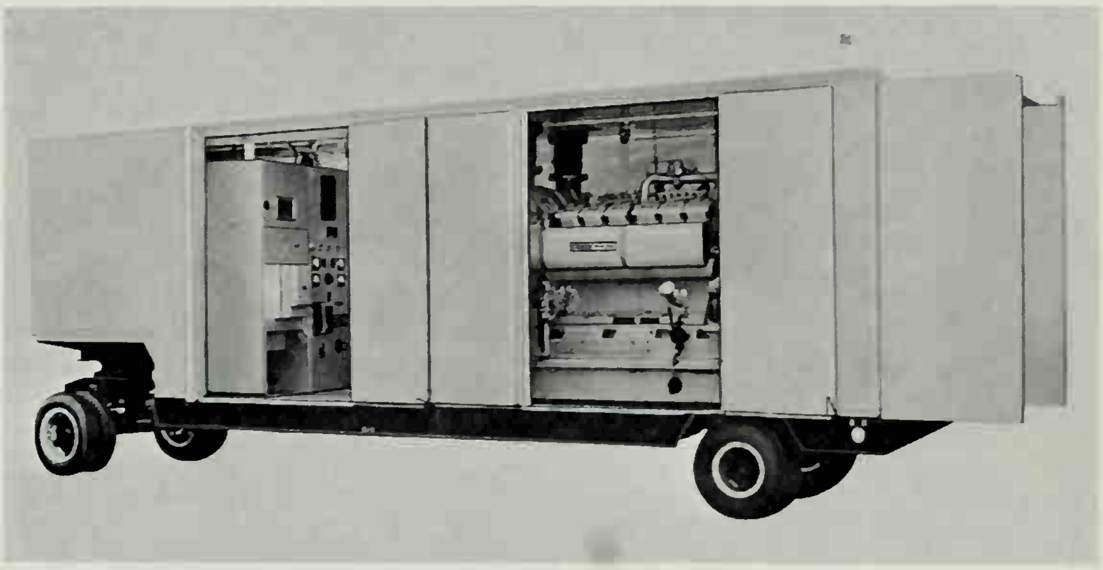
Weights are for engines with flywheel, electric starting equipment and filters

These outputs are applicable to engines operating in ambient air temperatures not exceeding 29°C (Types RPH, RPHX, YHX, YJX), or with the temperature of the water supply to the air intercoolers not exceeding 24°C or 41°C air-to-air cooling (Types RPHC, YHC and YJC), and at altitudes up to 150m (500ft)

A Management Company of English Electric Diesels Ltd
RUSTON PAXMAN DIESELS LIMITED
Vulcan Works, Newton-le-Willows, Lancashire, England
Telephone: Newton-le-Willows 5151 Telex: 62366

1968
1969

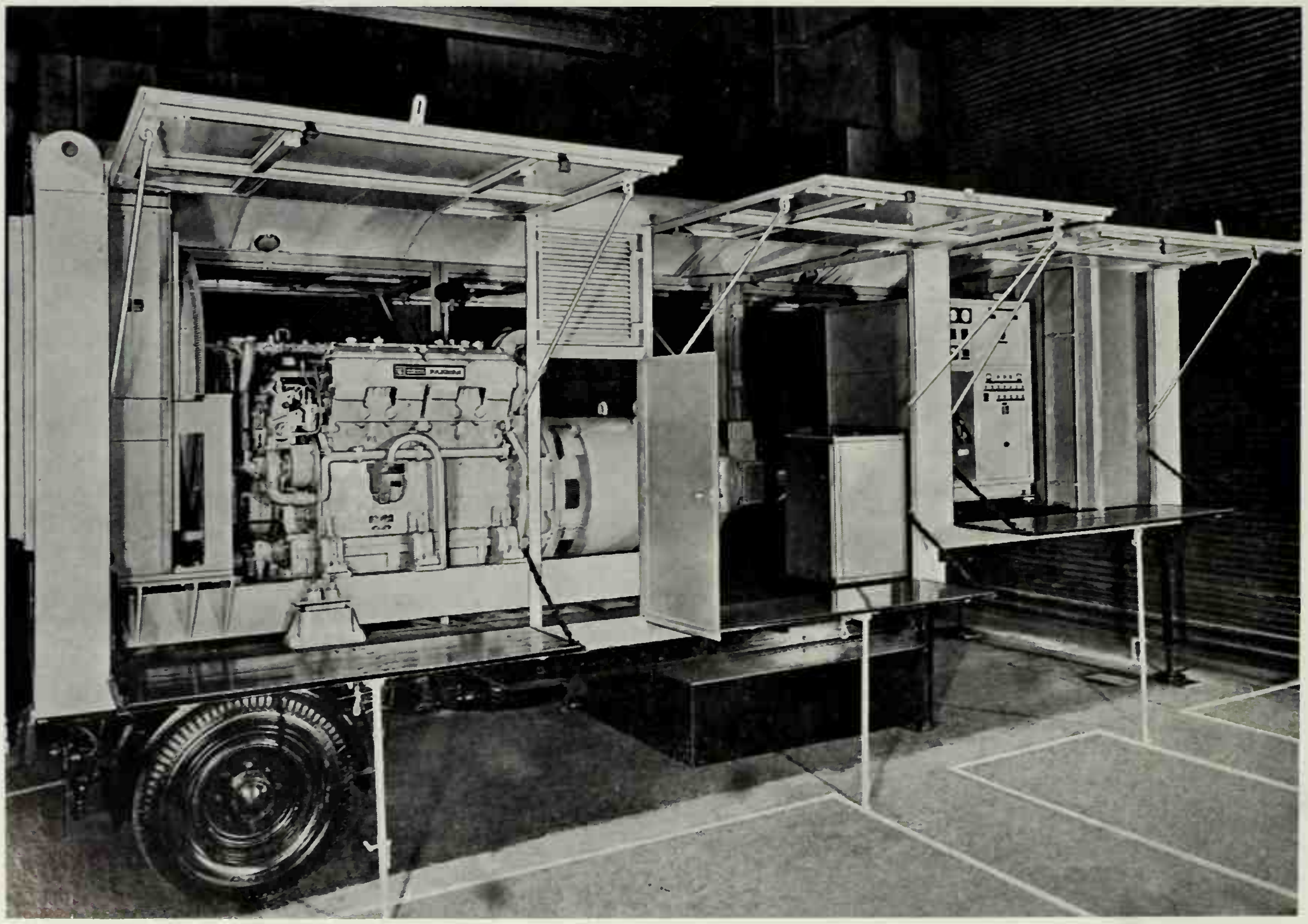




Top: powered by a Paxman 12 YHX engine, a 410kW remote or automatic starting set supplied in quantity to the Ministry of Defence (Air)

Centre: a 620kVA mobile generating set powered by a Paxman 12-cylinder YHX engine

Bottom: a trailer-mounted self-contained 200kW dual-frequency alternator set powered by a Paxman 8-cylinder RPHX engine



Power generating sets

Transportable and mobile diesel units

The compact dimensions and controlled weight of the Paxman range of diesel engines make this machinery ideally suited to power mobile generating plant, the range covering a power output of 100–1800kVA.

For more than 25 years the Paxman Engine Division has been engaged in the design and manufacture of transportable and mobile generating sets to meet the increasing demand for standby equipment. Skid-mounted sets complete with totally enclosing canopy can be provided as self-contained 'packaged' units requiring virtually no site preparation or lengthy installation procedures. Where the ultimate in portability is required, self-contained trailer-mounted sets capable of transportation to site and immediate operation can be supplied. With this equipment wide areas of potential power loss or sites remote from normal power supplies can be covered by a single unit with the minimum of delay.

Generators of both 50 and 60Hz can be supplied matched to the engine to meet most requirements. These machines can be of the conventional brushless or statically excited types with varying degrees of voltage and frequency control and of either single or two-bearing type. All equipments supplied comply with BS 2613:1957 as standard, but could be supplied to Lloyds Rules, ASA Standards or other international registration societies' regulations.

Stationary and 'no-break' sets can also be provided and these are covered on a separate page within this volume. Marine auxiliary generating sets manufactured by the Paxman Engine Division appear under the specific classification in this volume.

Typical outputs, dimensions and weights

Engine	Continuous rating rev/min						Standby rating rev/min						Overall dimensions				Approx wght	
	1500		1200		1000		1500		1200		1000		Length		Width		Dry	
	bhp	app. kW	bhp	app. kW	bhp	app. kW	bhp	app. kW	bhp	app. kW	bhp	app. kW	mm	in	mm	in	kg	lb
4RPH	160	110	153	101	133	88	176	121	168	111	146	97	1245	49	1295	51	2260	5000
4RPHX	203	138	192	130	173	117	223	154	211	143	190	127	1270	50	1320	52	2330	5120
4RPHC	250	171	248	167	232	156	275	188	273	184	256	171	1270	50	1295	51	2370	5225
6RPH	274	188	240	162	200	135	301	207	264	178	220	149	1475	58	1295	51	2790	6170
6RPHX	304	209	288	197	260	178	334	222	317	217	286	196	1525	60	1400	55	2840	6270
6RPHC	375	260	371	255	348	240	413	286	409	280	383	264	1225	60	1450	57	2880	6350
8RPH	366	255	320	218	267	180	403	281	352	240	294	198	1780	70	1295	51	3290	7230
8RPHX	406	284	384	264	346	238	447	312	422	290	381	262	1855	73	1400	55	3380	7453
8RPHC	500	348	496	342	464	324	550	383	546	376	511	356	1855	73	1450	57	3420	7000
12RPH	562	393	480	330	400	276	618	432	528	363	440	303	2310	91	1295	51	4540	10 000
12RPHX	610	423	576	398	520	358	670	465	634	438	572	374	2540	100	1500	59	4630	10 200
12RPHC	750	517	743	512	696	480	825	570	820	563	766	528	2540	100	1500	59	4700	10 350
12YHX	900	630	806	555	700	482	990	693	803	559	715	495	2540	100	1570	62	4980	10 970
12YHC	1050	735	900	625	800	555	1160	815	1000	700	880	610	2540	100	1570	62	5060	11 150
6YJX	550	380	500	345	450	310	605	418	550	380	494	341	1625	64	1420	56	3660	8050
6YJC	700	485	600	414	525	363	770	534	660	455	578	400	1625	64	1420	56	3750	8275
8YJX	750	520	670	465	600	415	825	572	737	512	660	456	1700	67	1345	53	4250	9350
8YJC	925	640	800	555	700	485	1018	705	880	610	770	534	1700	67	1345	53	4360	9600
12YJX	1150	810	1000	700	900	630	1265	891	1100	770	990	693	2060	81	1345	53	5180	11 400
12YJC	1400	985	1200	845	1050	742	1540	1084	1320	930	1155	816	2060	81	1345	53	5460	12 025
16YJX	1530	1080	1350	952	1200	850	1683	1188	1485	1047	1320	930	2590	102	1345	53	6950	15 300
16YJC	1850	1310	1600	1135	1400	985	2035	1440	1760	1250	1540	1084	2590	102	1345	53	7220	15 900

Standby rating is the power available from the engine for intermittent and standby duty

Continuous rating is the power available for base-load duty

Weights are for engines with flywheel, electric starting equipment and filters

These outputs are applicable to engines operating in ambient air temperatures not exceeding 29°C in the case of Types RPH, RPHX, YHX, YJX, or with the temperature of the water supply to the air intercoolers not exceeding 24°C, 41°C air-to-air cooling in the case of Types RPHC ,YHC ,YJC, and at altitudes up to 150m (500ft)

A Management Company of English Electric Diesels Ltd
RUSTON PAXMAN DIESELS LIMITED
Vulcan Works, Newton-le-Willows, Lancashire, England
Telephone: Newton-le-Willows 5151 Telex: 62366

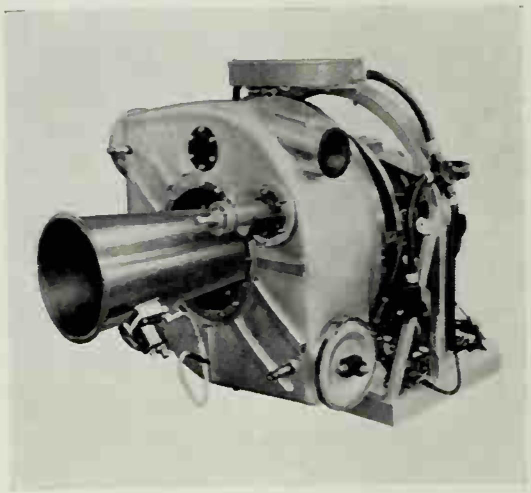
1968
1969

Gas turbines

for generating sets and other uses

Auto Diesels Braby Limited has been engaged for many years in the production and development of gas turbine-powered equipment. Extensive development work has been undertaken in various turbine applications and the present Stad turbine, of which over 200 are in service today as air-bleed units for starting jet aircraft, has now been adapted for shaft power applications.

Specification



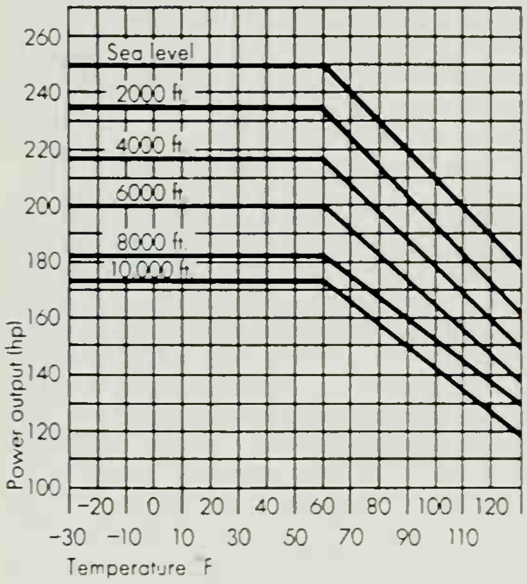
Type: Stad IS 250 gas turbine
Design: single-shaft, single-stage turbine with centrifugal compressor, radial inflow turbine, twin combustion chambers

Rated output: at turbine speed of 25 000 rev/min: 250 shp at 15°C and 1·03 kgf/cm² (14·7 lb²/in²). Ignition at 3000 rev/min; starting completed at 12 000 rev/min. Gearbox output speeds 1500, 1800, 3000, 3600, 4250 rev/min. Other speeds up to 8000 rev/min according to requirements. Direction of rotation facing drive-shaft: anti-clockwise. Air flow 2·54 kg/sec (5·6 lb/sec). Compressor ratio 3·7:1. Exhaust temperature maximum 650°C

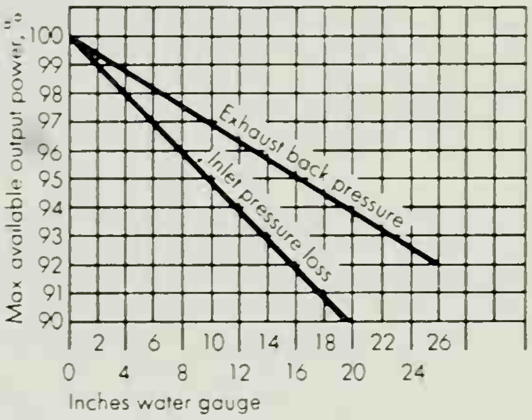
Fuels: JP1, JP3, JP4, MIL-G-5572 kerosene diesel, natural gas
Lub/oil: SAE 10 or SAE 20
Fuel consumption: see fuel consumption curve
Permissible inclinations: 20°
Dry weight: 272 kg (600 lb) including gearbox
Principal dimensions 1220 mm (48 in) length, 965 mm (38 in) width, 838 mm (33 in) height

Effects of installation variables

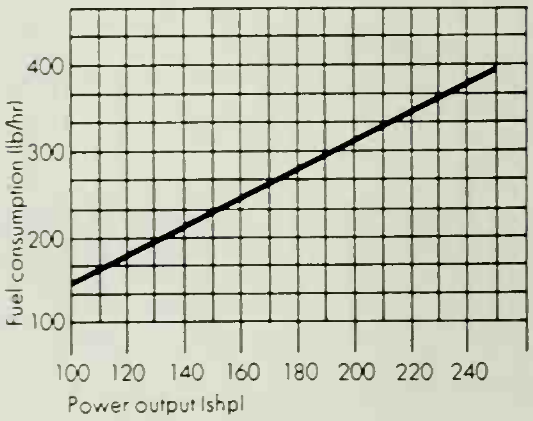
Air intake temperature and altitude



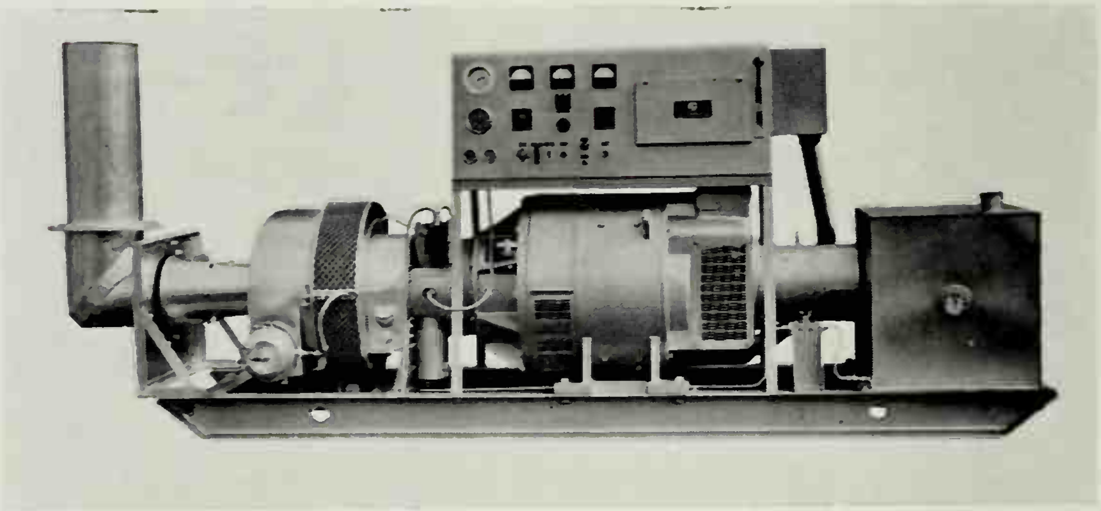
Air intake and exhaust outlet pressures



Specific fuel consumption shaft horsepower



250 shp applications



Air compressor sets
Stad IS 250 turbine directly coupled to BroomWade compressor set. Specially mounted on trailer undercarriage. Typical output 40 m³/min (1400 ft³/min) at 7·7 kgf/cm² (110 lbf/in²)

Pumping sets
Typical pumping sets available with Stad IS 250 as prime mover. Output 11 365 litres/min (2500 gal/min) at 7 kgf/cm² (100 lbf/in²) at 70 m (231 ft) head: 19 775 litres/min (4350 gal/min) at 4·6 kgf/cm² (65 lbf/in²) at 46 m (150 ft) head

Alternator sets
Skid-mounted typical application shows 200 kVA three-phase 50 Hz unit. 60 Hz and 400 Hz also available. Suitable for aircraft ground power units. DC voltages available according to requirement

Note: the Stad turbine, manufactured at the Uxbridge Works in the A250 and A260 form, is also used for air-bleed applications delivering air up to 72·6 kg/min (160 lb/min at 2·8 kglf/cm² (40 lbf/in²) and at normal temperature, and pressure conditions

AUTO DIESELS BRABY LIMITED
Cowley Mill Road, Uxbridge, Middlesex, England
Telephone: Uxbridge 38262 Cables: Courteous Uxbridge Telex: 263835

BRABY

Small gas turbines, turbo-compressors, turbo-generator sets, de-icers, turbo-fans

The Budworth Puffin gas turbine is a lightweight unit for use as turbo-compressor, pure jet engine, turbo-fan unit and for driving ground and other equipments through reduction gearing. It is also available as a turbo-prop engine and de-icing unit.

The single-stage, single-side centrifugal compressor driven by two axial turbine wheels delivers 90 kgf (200 lbf) static thrust; with a free turbine up to 250 hp is provided to drive a centrifugal compressor with an output of 1·27 kg/sec (2·8 lb/sec) of air at 2·6 kgf/cm^2 (2½ atm). Weighing approx 45 kg (100 lb), multiple units on a common gearbox are available. The turbo-fan unit gives 270 kg (600 lb) static thrust; the de-icer provides 0·9 kg/sec (2 lb/sec) of air at 600°C. A slightly larger turbine the Blowfly (400 hp), is also available.

David Budworth Ltd
Kings Quay Street, Harwich, Essex, England
Telephone: Harwich 3116
Cables: Budworth Harwich

Section 29

Rescue equipment

All Beaufort inflatable lifejackets:

(1) are light in weight, compact in folding, and do not inconvenience the wearer in his duties;
(2) are designed for a specific function;
(3) are self-righting and float the wearer inclined backwards at approximately 45 deg, with his mouth well clear of the water;
(4) do not ride over the head, or injure the wearer when jumping or parachuting into water;
(5) are designed to carry a wide range of location aids (pyrotechnic flares, fluorescine sea markers, heliographs, radio location aids whistle, etc) which can be fitted to customer's requirements;
(6) can be fitted with oral inflation; manual or water-activated compressed gas inflation; or in the case of aircrew lifejackets, with ejector seat static line inflation (without fouling the parachute harness).

Aircrew lifejackets

Suitable for subsonic aircraft, the Mk 4A and its alternative forms Mk 4B, 4C, 6 and 7 are fitted with different rescue location aids. The Mk 8 is an integral part of an underwater ejection escape system for carrier-based aircraft.

Approved for supersonic aircraft, the Mk 9B shown below, as well as Mk 10, 11, 12 and 14 have been ejection-tested at 1200 km/h (650 knots) ground level, without sustaining damage. The Mk 10, 11 and 12 secure an integral personal parachute harness and man-mounted oxygen regulator.

Mk 9B Aircrew (22C/2774)

Passenger lifejackets

For transport of troops and families by air, passenger lifejackets for constant wear and seat or rack stowage are manufactured for adults and children, including the baby's floating survival cot.

Army lifejackets

With a buoyancy of 37 kg (80 lb) the parachutist's lifejacket shown below enables a trooper to reach land complete with weapons, ammunition and equipment. It can be inflated during descent, and discarded in 5 seconds. A variation designed for assault troops is suitable for longer periods of wear, allows greater freedom of movement and can be discarded while running.

The canoeist's and diver's lifejacket does not hinder paddling and is compatible with breathing equipment.

For over-water engineering and pioneer work, the engineer's lifejacket is light and comfortable, allows freedom of movement, and is abrasion- and flame-resistant. The engineer's inherently buoyant aid is manufactured from closed-cell expanded foam contained in a fabric cover and so withstands heavy wear and rough treatment.

Parachutist's (22C/2343)

Naval lifejackets

The Pattern 5580 shown below is an inexpensive general-purpose lifejacket, with oral inflation only. Normally worn in a pouch around the waist, the inflatable stole may be easily donned in times of danger. In its Mk 10 Naval form CO_2-inflation is fitted.

Folded into a pouch when deflated the Mk 9 Naval lifejacket is worn by personnel working in dangerous positions which require unrestricted mobility, such as refuelling at sea. Inflation can be automatic on immersion, or manual.

Naval (Pattern 5580)

Beaufort protective and survival clothing:

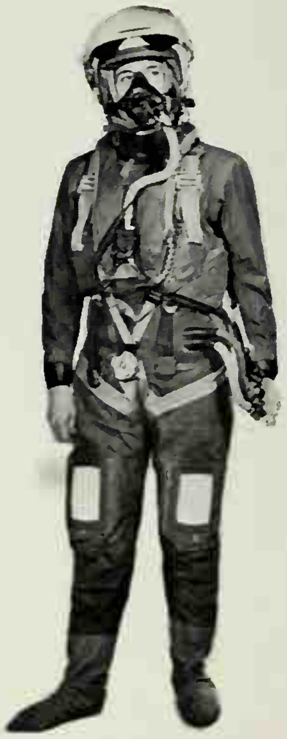
(1) has been designed and developed in co-operation with the appropriate government, military authorities and test establishments;
(2) provides a very wide range of protection against the hazards or discomforts encountered in specialised military operations;
(3) ensures minimum bulk and weight, maximum strength, and ease and speed of donning;
(4) integrates with any other specialised clothing as seen below left, to ensure optimum operational efficiency.

Coverall, high-altitude, anti-g, ventilated Mk 2 (22C/1300204-13)

Aircrew pressure clothing

Pressure protective suits, for altitudes up to 36 500 m (120 000 ft) may be separate garments or combined with anti-g and air-ventilated protection (right) in any combination for different operational roles. Combined suits reduce dressing time, weight and discomfort; the g section raises g resistance by about 2g.

A wide variety of extremely light anti-g suits is available. They are capable of raising g-tolerance by up to 2g. Inflation hoses can be fitted in any position to suit aircraft supplies.



A typical integrated aircrew equipment assembly

Survival equipment

Lifejackets, clothing, liferafts and boats

Beaufort inflatable liferafts:

(1) provide the specific answer to an operational requirement. There is no such thing as a 'universal' liferaft. For example, the problems of escape and survival are different when abandoning a ditched jet aircraft or a stranded hovercraft;
(2) are made from coated fabrics produced in our own mill under the strictest supervision, many formulated by our own laboratories;
(3) are packed in either glass-reinforced plastic containers or proofed valises, which adequately protect the liferaft in the various types of stowage location available;
(4) are provided with an emergency pack, selected by the user to meet the survival needs of the various climatic and geographical conditions of operation;
(5) are backed by over 100 service stations in 37 countries.

Naval liferafts

Based on the 1960 SOLAS requirements, Beaufort Naval Liferafts Types X (right), Q and R have been adopted by navies throughout the world in preference to out-dated anomalous designs. The liferafts can be modified to suit the specific requirements of operational equipment.

Naval liferaft Type X

Hovercraft liferaft

Because of the high passenger/crew ratio, hovercraft liferafts require the minimum of crew time during an emergency. The Hovercraft Liferaft Type H.30 (right) is automatically inflated after manual ejection, and the wide, straight entrances allow rapid and easy boarding. The rigid container is designed for open-deck stowage on high-speed craft.

Hovercraft liferafts

Aircraft liferafts

Varying from one-man to 25-man sizes, aircraft liferafts are designed for minimum weight and packed bulk compatible with flotation and survival characteristics for the climatic conditions of operations. Pack designs are available to suit any aircraft stowage.

Thermal controlled clothing

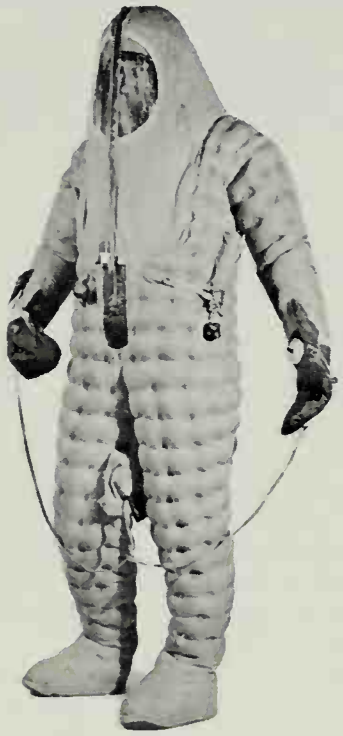
Suits are available to cool or heat the wearer in either hot or cold ambient temperatures, or to combat the excessive heat load of other essential protective clothing.

Either air conditioning or liquid conditioning, depending on operating conditions and supplies, is available. Liquid-conditioned suits utilise smaller pipe bores and have minimum power requirements. Portable conditioning units are available.

Immersion and exposure suits

By keeping survivors dry and reducing body heat losses, the survival period in climates where exposure can be fatal is extended. A wide range of suits is manufactured in various materials and designs to meet the operational requirements in the air, on sea and on land. The Mk 10 Immersion Coverall (right) is a typical example. A special case is the Submarine Escape and Immersion Equipment (SEIE, far right), which is suitable for escape from depths down to 150 m (500 ft) and provides prolonged exposure protection on the surface.

Mk 10 Coverall, Immersion

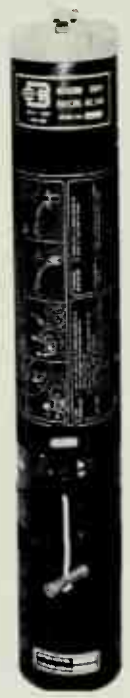

SEIE

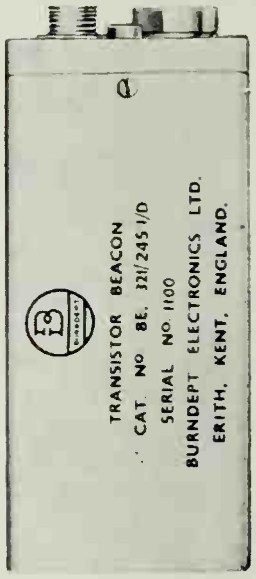
BEAUFORT (AIR-SEA) EQUIPMENT LTD
Beaufort Road, Birkenhead, Cheshire, England
Telephone: 051-652-2667 Telex: 62478

By Appointment to
H. M. Queen Elizabeth II
Suppliers of Life Saving Equipment

SARBE equipment

SARBE
COMPACT
BEACON
BE.355/121·5/S
Serial № 1081
BATTERY TYPE NO.
SERIAL NO.
DATE OF MANUFACTURE
Burndept Electronics Ltd.
Erith, Kent, England

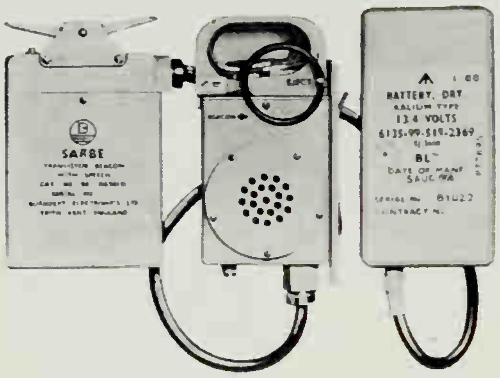




BE.355 Compact Survival Beacon (above) is designed primarily for civil aviation and private airline operations, but is also of great interest to private fliers and yachtsmen who may operate in areas where a simple but sure survival radio is of the utmost importance.
The battery and transmitter are clipped together as one unit and the only action required by the survivor is to extend the aerial which automatically operates the transmitter

BE.361 Personal Locator Beacon (above) is designed to be life jacket or liferaft mounted, and provision is made to use the inflation of these items to release the aerial and switch on the beacon automatically. The beacon and battery are stowed in a cassette, and the aerial is mounted separately

BE.346 Self-buoyant Automatic Radio Distress Beacon (above, left) transmits simultaneously on the two international distress frequencies. Designed for civil airline use, it operates entirely automatically once ejected into the sea. The water-soluble band retaining the aerial and stabilisers dissolves within five minutes, allowing the aerial to spring erect and switching on the transmitter. When in the sea the BE.346 may be attached to the survival dinghy by 9m (30ft) of nylon towline with a 272kg (600lb) breaking strain. A handle can be fitted

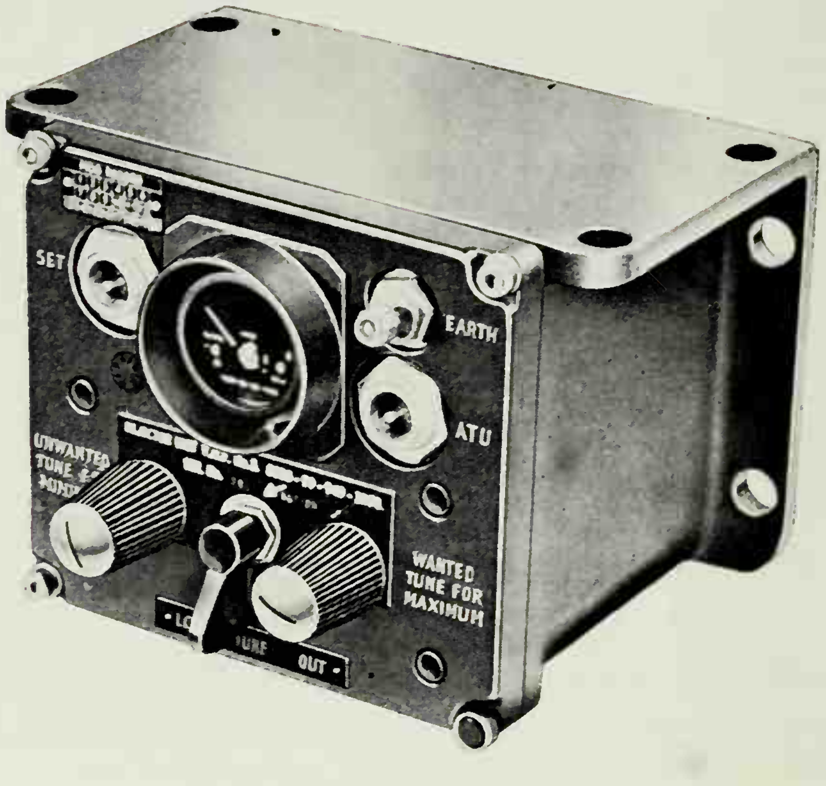


BE.310 Survival Beacon with Speech (left) is basically the same as BE.361 but has the additional facility of speech. This enables the survivor to assist in his own rescue, as well as permitting the relative luxury of being able to talk with the rescue party. The equipment comprises three units: transmitter/receiver, microphone/aerial unit and battery pack

BE.321 Equipment Recovery Beacon (above, right) has been developed to fill the growing need for a reliable locator beacon for the quick recovery of crash recorders, practice missile warheads, meteorological balloons, marker buoys and similar equipment. Completely automatic, it operates on predetermined frequencies in the VHF/UHF wavebands

VHF rejector unit

Rejector Unit VHF No. 3 is designed to reduce the mutual interference between VHF transmitter/receivers. Input/output impedance is 70Ω.
The unit contains a tuneable filter network over the frequency band 23-60MHz.
When correctly tuned, the unit will attenuate the unwanted signal by not less than 20dB.
The total insertion loss when the unit is correctly tuned is not greater than 2dB in these conditions, and not greater than 0·6dB when the unit is switched out.
The equipment, when mounted on suitable shock mounts, is capable of being operated in armoured and unarmoured vehicles and of withstanding normal forward area rough usage. It is capable of operating at heights up to 3000m (10000ft) and of transportation by air in unpressurised aircraft at altitudes up to 7600m (25000ft). It is sufficiently robust to withstand dropping by parachute using standard equipment.
The unit is contained in a sealed aluminium box, approximately 178 × 115 × 115mm high (7 × 4½ × 4½in high), and its weight is about 2·8kg (6¼lb).



Rescue equipment

Search and rescue beacons

From the early days of the 'conquest of the air' intense research has been applied to crash rescue and Burndept Electronics (ER) Ltd has played a leading part in this work. Search and rescue beacon equipment (SARBE) was Burndept's answer to the early optical devices (smoke, flares, etc.) whose effectiveness was severely limited in range and, in any case, quite useless in conditions of poor visibility.

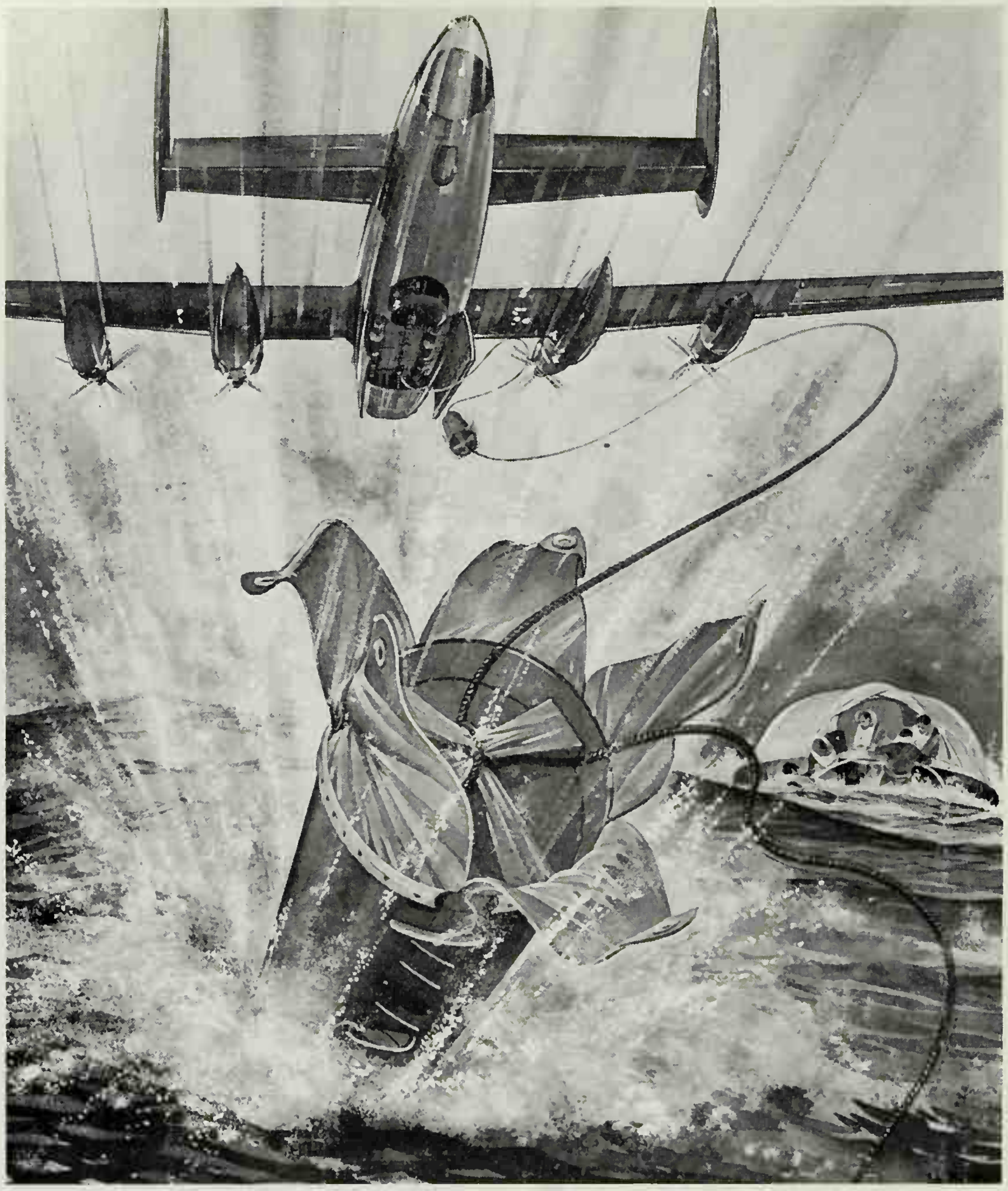
By the miniaturisation of radio components Burndept was able to produce a battery-operated radio transmitter operating on a distress frequency. Once the practicability of the equipment had been established and proved there was continuous development which produced ever more compact and more efficient equipment. This intense development, of course, continues unceasingly but the latest SARBE models are of such sophistication and range that new advancements are likely to be more apparent to the 'boffin' than the 'man in the drink'. The present range of SARBE beacons is around 320km (200 miles) to an aircraft at 9000m (30000ft).

Although human survival is unquestionably the more dramatic aspect, SARBE locator beacons are proving invaluable in the recovery of crash recorders, practice space missiles, meteorological balloons and other objects that are sent into the sea and the immediate recovery of which is imperative. Special SARBE equipment is also in use in marker buoys and similar navigational aids.

Technical data

	BE.310	BE.346	BE.355	BE.321	BE.361
Carrier frequency	243 or 121·5MHz, crystal controlled	121·5 and 243MHz simultaneously, crystal controlled	121·5MHz, crystal controlled	243 or 121·5MHz, crystal controlled	243 or 121·5MHz, crystal controlled
Power output, with nominal input	250mW mean during pulse, 400mW peak	250mW mean at each frequency, 400mW peak	100mW mean, 200mW peak	250mW mean during pulse, 400mW peak	250mW mean during pulse, 400mW peak
Range, sea-to-air at 3000m (10000ft)	*Beacon mode:* 60 nautical miles *Speech mode:* 10 nautical miles	60 nautical miles	50 nautical miles	60 nautical miles	60 nautical miles
Aerial	Self-erecting steel tape	Self-erecting single element vertical	Telescopic	No aerial fitted, but has 50Ω output socket	Self-erecting steel tape
Modulation characteristics	Amplitude modulated *Beacon mode* not less than 60% by audio frequency of 1020Hz ±250Hz	Swept tone modulation at a rate of 2–3Hz	Swept tone modulation at a rate of 2–3Hz	Amplitude modulated not less than 85% by audio frequency of 1020Hz ±250Hz	Amplitude modulated not less than 85% by audio frequency of 1020Hz ±250Hz
Emission characteristics	*BE.* 310/*A*: A2 with carrier and modulation keyed, pulse duration 0·75sec 'on', 3·0sec 'off'. *BE*.310/*D*: A2 with carrier and modulation keyed, pulse duration 1·0sec 'on', 1·0sec 'off'	A2—continuous carrier	A2—continuous carrier	*BE*.321/*A*: A2 with carrier and modulation keyed, pulse duration 0·75sec 'on', 3·0sec 'off'. *BE*.321/*D*: A2 with carrier and modulation keyed, pulse duration 1·0sec 'on', 1·0sec 'off'	*BE*.361/*A*: A2 with carrier and modulation keyed, pulse duration 0·75sec 'on', 3·0sec 'off'. *BE*.361/*D*: A2 with carrier and modulation keyed, pulse duration 1·0sec 'on', 1·0sec 'off'
Associated battery	G 1339 Mercury-zinc, 13·4V	G 1420 Mercury-zinc, 13.4V	G 1437 Mercury-zinc, 13.4V	G 1339	G 1339/6 Mercury-zinc, 13·4V
Battery endurance at 4°C after storage	*BE*.310/*A*: 75h *BE*.310/*D*: 32h	48h, at 0°C	*Standard:* 48h, at 0°C	*BE*.321/*A*: 75h *BE*.321/*D*: 32h	*BE*.361/*A*: 75h *BE*.361/*D*: 32h
Environmental conditions	0–50°C	0–55°C	0–50°C	0–50°C	0–50°C
Size overall:					
Beacon	124 × 90 × 31mm ($4\frac{7}{8} \times 3\frac{1}{2} \times 1\frac{1}{4}$in)	660 × 127mm dia (26 × 5in dia) including battery	145 × 100 × 31mm ($5\frac{3}{4} \times 3\frac{3}{4} \times 1\frac{1}{4}$in) including standard battery	108 × 44 × 38mm ($4\frac{1}{4} \times 1\frac{3}{4} \times 1\frac{1}{2}$in)	108 × 44 × 38mm ($4\frac{1}{8} \times 1\frac{3}{4} \times 1\frac{1}{2}$in)
Speech unit	150 × 73 × 30mm ($5\frac{7}{8} \times 2\frac{7}{8} \times 1\frac{7}{32}$in)				192 × 35 × 47mm ($5\frac{5}{8} \times 1\frac{3}{8} \times 1\frac{7}{8}$in)
Battery	133 × 65 × 34mm ($5\frac{5}{32} \times 2\frac{19}{32} \times 1\frac{11}{32}$in)			133 × 65 × 34mm ($5\frac{5}{32} \times 2\frac{19}{32} \times 1\frac{11}{32}$in)	133 × 65 × 34mm ($5\frac{5}{32} \times 2\frac{19}{32} \times 1\frac{11}{32}$in)
Weight:					
Beacon	Both units, 780g (27·5oz)	5·3kg (11·75lb) including battery	850g (30oz) including standard battery	226g (8oz)	483g (17oz)
Battery	653g (23oz)			653g (23oz)	653g (23oz)
Design specification	Stanag 3281	Eurocae MPS1/WG4/ 65 MOA CAP 208–1–10 ICAO annex 10	Burndept	Burndept	Stanag 3281

BURNDEPT ELECTRONICS (ER) LTD
St Fidelis Road, Erith, Kent, England
Telephone: Erith 39121 Cables: Electronics Erith Telex: 21246



Dropping swift aid to survivors in open boats, liferafts or in the water. Various combinations are available for fitting to bomb bays of long-range aircraft or for simple manual ejection from cabin doors

Other RFD-GQ products for rescue or fire fighting work

Raft Type 'F' Bikini

In construction the RFD-GQ Bikini basically comprises four independent buoyancy tubes which are inflated from two built-in gas cylinders. The buoyancy tubes are constructed of tough three-ply fabric, heavily rubber-proofed and resistant to rot and abrasion.

In its fire-fighting role the Bikini carries three lightweight fire pumps and is normally used to raise water to main feed pipelines, or as an independent self-propelled pump for fires along the water's edge

Inflatable Z-boat

Tough, stable and readily manoeuvrable under most conditions, the Z-boat is available in three sizes. The PB-16 illustrated is of the type in use with the Royal National Life-boat Institution for inshore rescue work

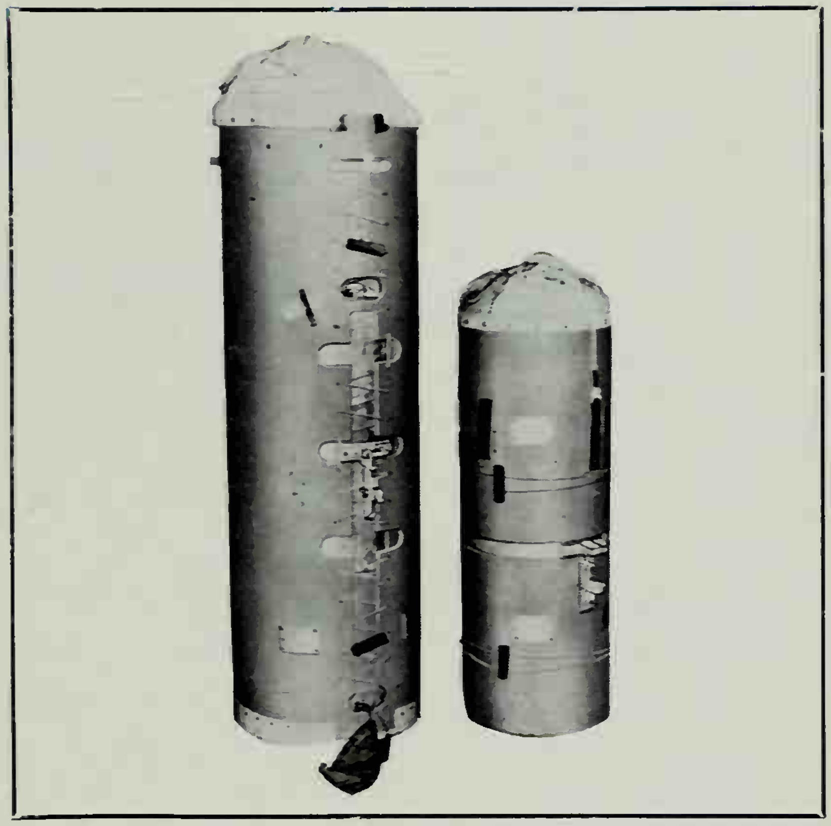
By appointment to
Her Majesty Queen Elizabeth II
manufacturers of Inflatable Boats
RFD-GQ Limited Godalming

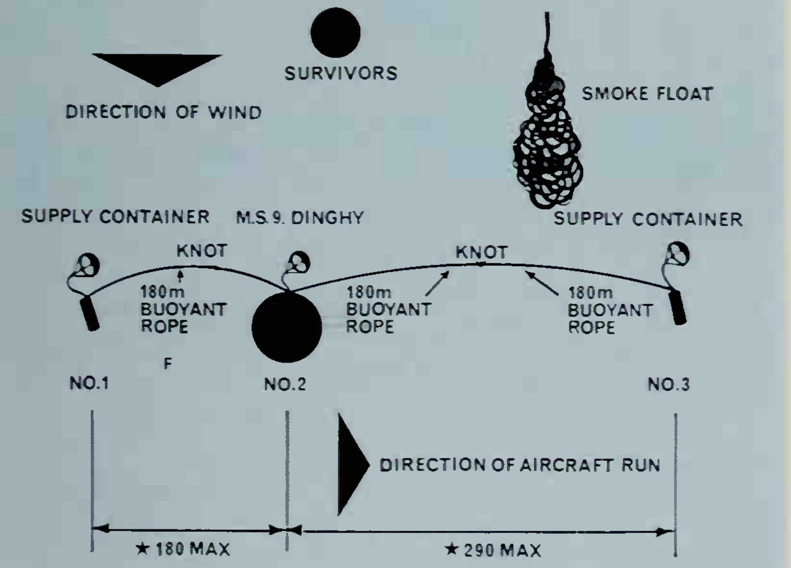
Air-sea rescue apparatus

for swift aid to survivors

RFD-GQ air-sea rescue apparatus (Lindholme Mk3 dropping gear) forms a vital part of the rescue services of many nations.

Intended for dropping by aircraft, this apparatus offers comprehensive aid to survivors. It supplies a canopied liferaft with exposure protection, food and survival equipment allowing survivors to remain relatively comfortable and safe until rescued. Stowed inside or outside the fuselage, or in the bomb bay of the aircraft, the standard apparatus consists of three rigid containers connected by means of a 584·5 m (600-yd) buoyant line. The customary procedure is to drop a marking smoke float (which also acts as a wind-direction indicator), run down-wind of the survivors across their path and drop the containers (still connected) at timed intervals. On striking the water the liferaft inflates within 20 to 30 seconds. Acting as sea anchors, the drogues retard the drift of containers and liferaft container can be varied, as can the scale of supplies.





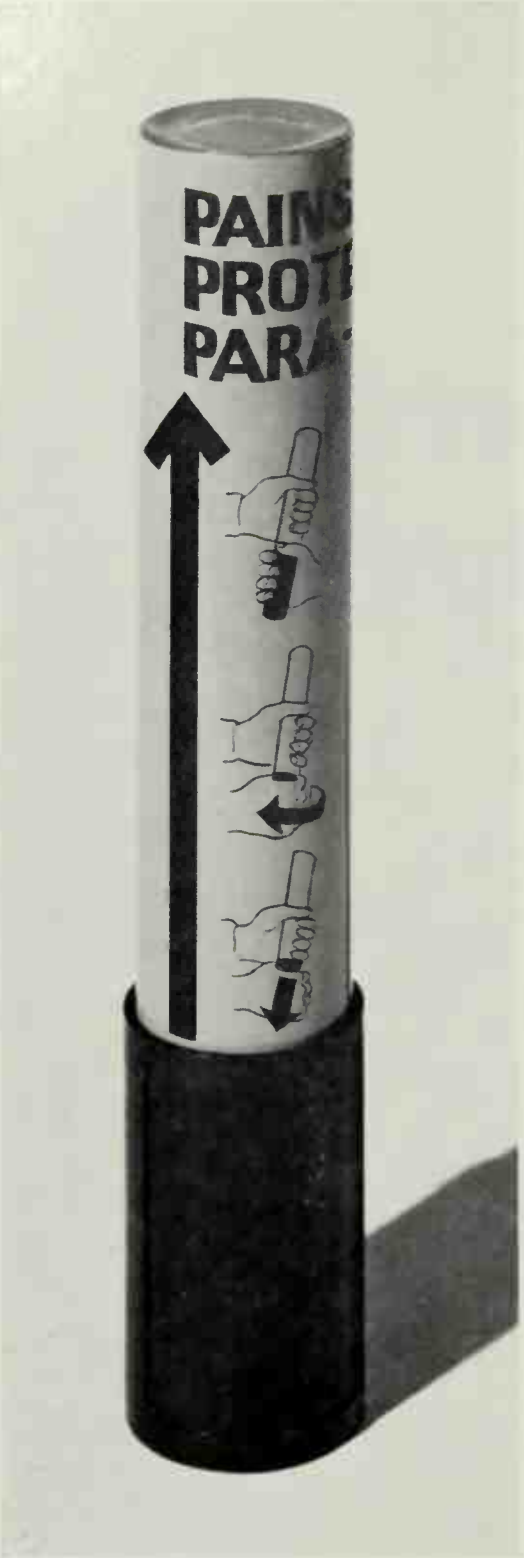
★Dropping speed 260 km/h (140 knots) at 48 m (160 ft). Limits may vary with speed and height

The apparatus comprises a nine-man inflatable liferaft in container weighing 56·69 kg (125 lb) and two linked supplies containers each weighing 30·85 kg (68 lb). The normal contents of a supplies container are as follows:

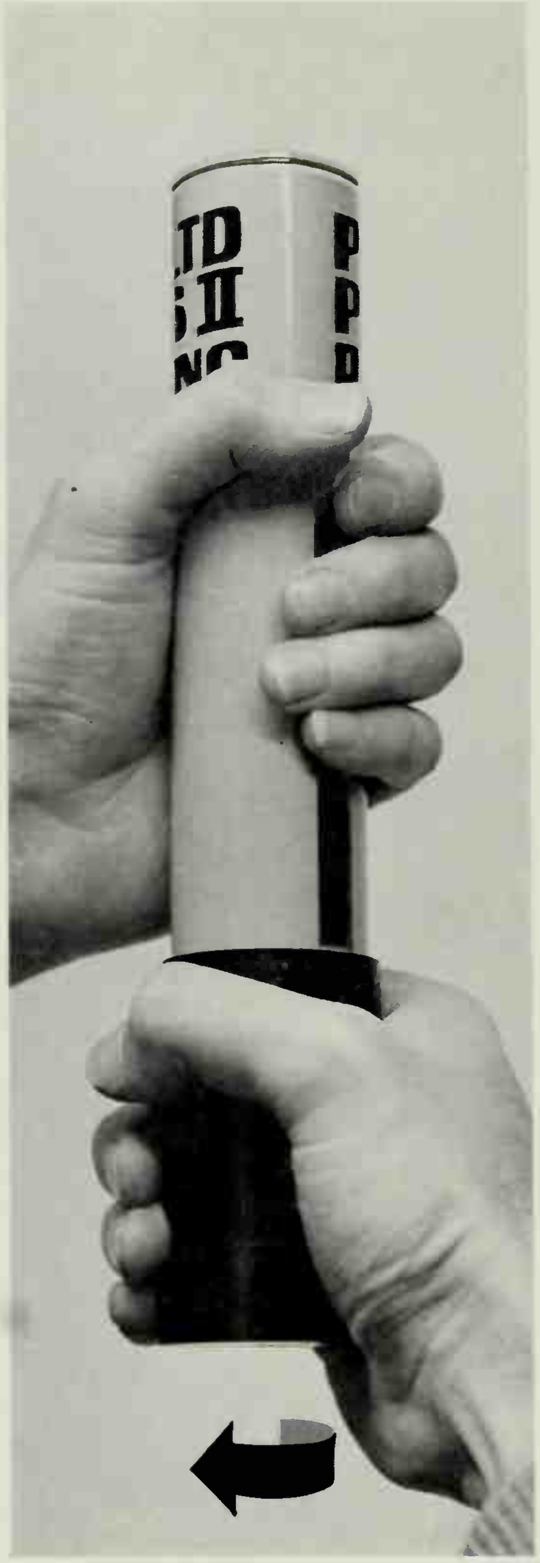
Five 6-pint de-salting sea-water apparatus; two water carriers; five packs of cigarettes; two cup/balers; one first-aid kit; one heliograph; one Zermopak hotbag; one ground/air emergency-code label; three tins of condensed milk; one sea-survival pamphlet; one pack of playing cards; three emergency rations; two inflatable casualty sleeping bags; five distress signals, day and night; four cans of water; one plastics air-crew whistle.

RFD-GQ LIMITED
Godalming, Surrey, England
Telephone: Godalming 4122 Cables: Airships Godalming Telex: 85233

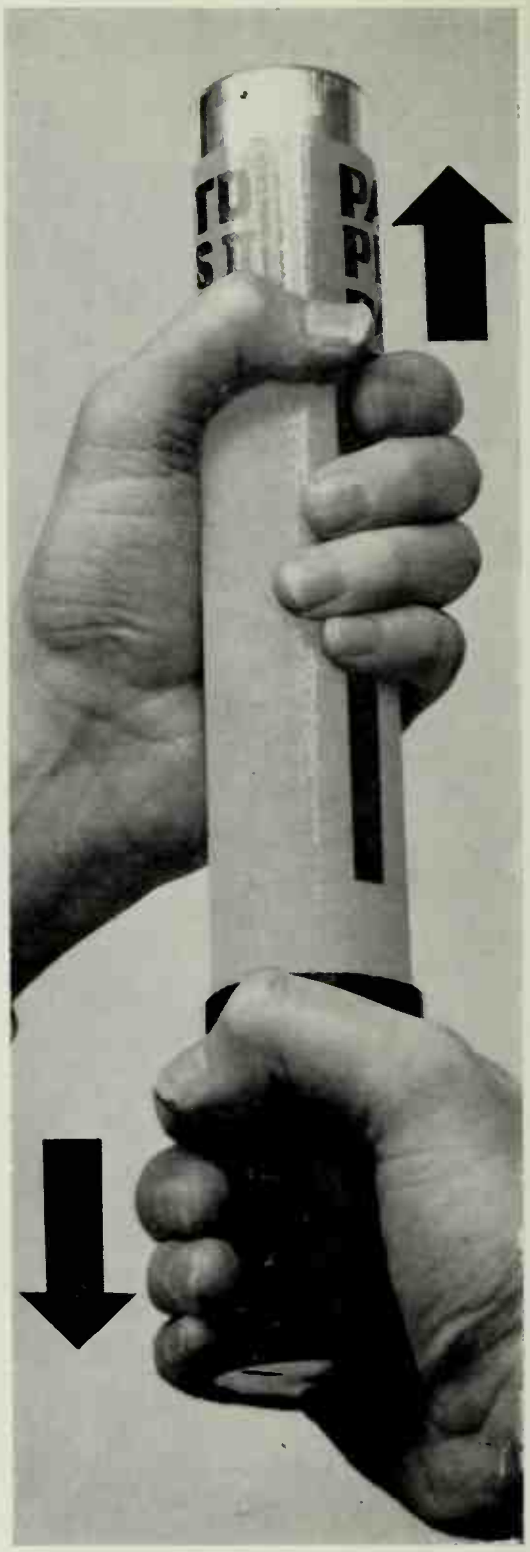
Section 30
Pyrotechnics


PAINS
PROTE
PARA

The Proteus Series hand-held rocket has no tapes that require removing



Turning the twist grip breaks the bottom seal and dislodges the sealing disc at the top



Firing the rocket is achieved by simply pulling the twist grip gently down

PAINS WESSEX
PENROCKET
PENFLARE
PENSMOKE

Left: the Pen Series—a convenient miniaturised range of signalling equipment

Hand-held rockets

and flares for signalling

Proteus Series rockets

The development of the Proteus Series of hand-held rockets has been specifically aimed at simplifying the firing sequence for this type of equipment. It has been achieved by dispensing with the use of tapes and introducing a twist-grip sleeve which requires only a turn and pull for firing. This system allows the rockets to be brought rapidly into use while being firmly held with both hands. The design also gives the equipment the ability to withstand a wide range of environmental conditions.

The rocket launch tube is of thick-walled aluminium the surface of which is treated to give protection against corrosion. It is sealed at the top by a disc fitted with an O-ring, and at the bottom by a compressed butyl rubber gasket. Turning the twist grip breaks the lower seal and moves the rocket upwards by means of a cam. This upward movement dislodges the sealing disc at the top. A stop prevents the twist grip being rotated through more than ¾ turn. At this point the twist grip is pulled down to a second stop and the rocket discharges with negligible recoil.

The rocket body is of extruded aluminium alloy. The motor uses a plastic propellant which has British Government approval; it burns with a non-luminous gas flame and leaves no spark trail. Ignition, which occurs when the twist grip is pulled down, is instantaneous and is produced by means of an uncocked striker. The rocket is held within its launch tube until ignition occurs.

The standard Proteus rocket is 26·7 cm (10·5 in) long, but to meet special service requirements there is a shorter version of 24·1 cm (9·5 in) having a payload of illuminating or coloured flares.

Whatever their payload, all Proteus rockets are of the same basic design and construction. Except for the parachute-illuminating role the rockets would normally be fired at or near the vertical.

Common characteristics
Length: 24·1 cm (9·5 in) or 26·7 cm (10·5 in)
Diameter: 4·1 cm (1·625 in)
Weight (approx, depending on payload): 24·1 cm–340 g (12 oz); 26·7 cm–400 g (14 oz)
Height, fired vertically: 365 m (1200 ft)

Common designed environmental conditions
Temperature range: storage −40° to +90°C; operation −25°C to +70°C
Water immersion test: 3·16 kgf/cm^2 (45 lbf/in^2) for 1 h
Vacuum test: 0·625 atmospheres
Drop test: from 1·83 m (6 ft) on either end of 0°C to +70°C

Illuminating parachute flare
The flare is supported by a nylon parachute of large diameter which minimises the swing and gives a slow rate of descent.
Range to burst (approx at 45° QE): 300 m (330 yd)
Height of burst (approx at 45° QE): 180–210 m (600–700 ft)
Burning time: 24·1 cm type—30 sec; 26·7 cm type—40 sec
Candle power: 100 000

Other parachute flares
These signals are similar to the illuminating rocket but carry payloads which are parachute-supported red or green flares. They are normally fired vertically and burst at 365 m (1200 ft).

Smoke streamer
When fired vertically, the rocket begins to emit smoke (yellow or orange) at about 61 m (200 ft) and continues this until just after the top of its flight at 365 m (1200 ft).

Multistar
These rockets carry up to four stars, in red, green or white, and are used for signalling purposes.

Maroon
The rocket carries an explosive charge which produces a report that can be heard at distances of several kilometres.

Target-marking parachute rocket
This rocket is used for location or target marking and for gunnery practice. It ejects a large-diameter fluorescent orange parachute which has a very low rate of descent.

Radar-reflecting rocket
A radar-reflecting device is ejected from this rocket and provides a suitable target for all types of radar transmission. When the rocket is fired vertically the target is ejected at about 365 m (1200 ft) and then descends slowly.

Pen Series signalling equipment

The Pen Series of equipment offers a convenient and miniaturised version of pyrotechnic signals to meet many service needs. To operate, it is only necessary to screw the required signal into the pen gun, then pull back and release the trigger. Although originally developed to meet the need for compact distress aids for aircraft, its small size makes it ideal for many other uses, particularly by ground troops.

Pensmoke
The Pensmoke gives out a dense cloud of smoke (normally orange) for approx 18 sec.

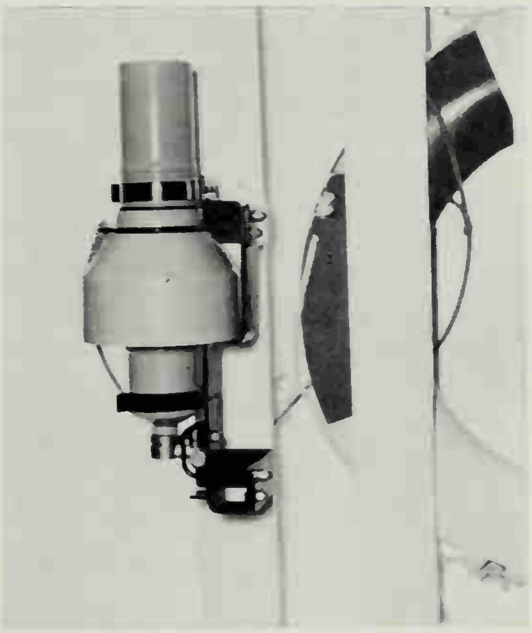
Penflare
The Penflare is the same size as the Pensmoke. It has a red flare that burns for about 20 sec at 15 000 candle power.

Penrocket
The Penrocket is percussion-ejected from its case before the motor ignites and carries it to over 305 m (1000 ft) when fired vertically. The payload can be single or multistars of any colour, a smoke trace, a smoke puff or a star and smoke.

Ministars
There are two types, each having a colour range of red, white or green. In one type the star is ejected to a mean height of 61 m (200 ft) and burns for at least 5 sec, in the other to over 91 m (300 ft) and burns for at least 5 sec above 61 m (200 ft).
Candle powers: Red and White—7500
Green—5500

Minismoke
The Minismoke is identical in size with the Ministar but emits a coloured smoke trace over most of its trajectory. Smoke colours are orange, red, yellow, green or blue.

PAINS-WESSEX LIMITED
High Post, Salisbury, Wiltshire, England
Telephone: Middle Woodford 282   Cables: Painwessex Salisbury



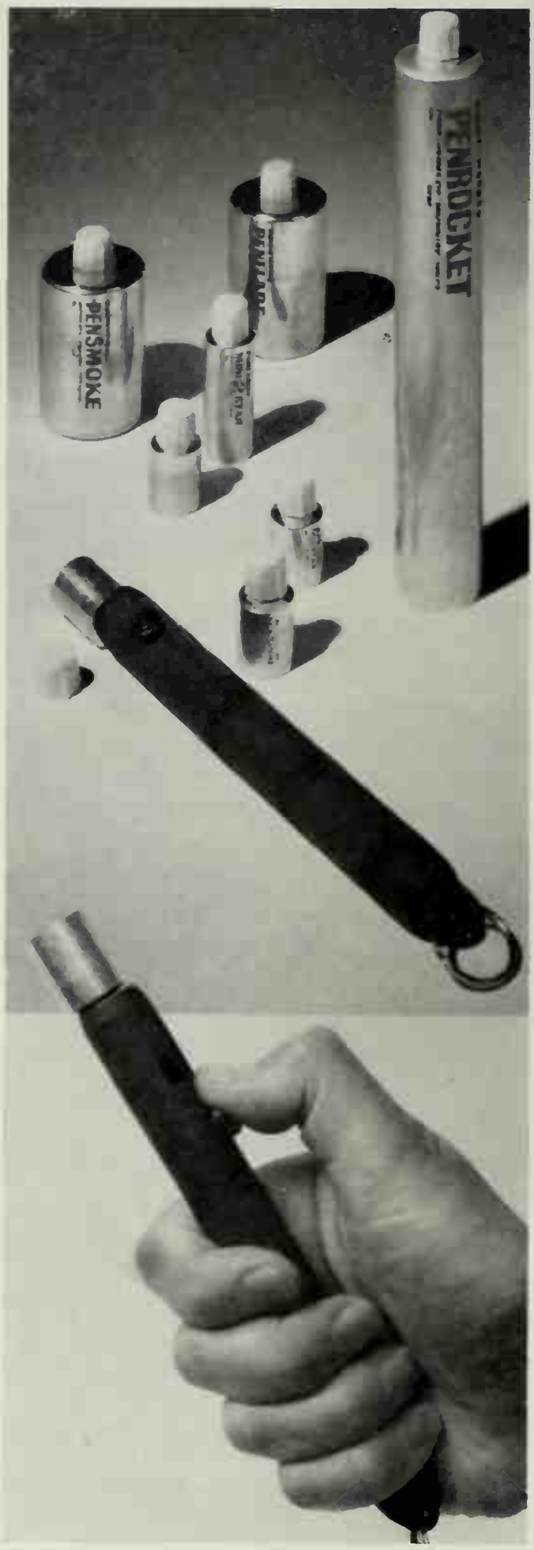
Above: Manoverboard marker provides a signal by day or night

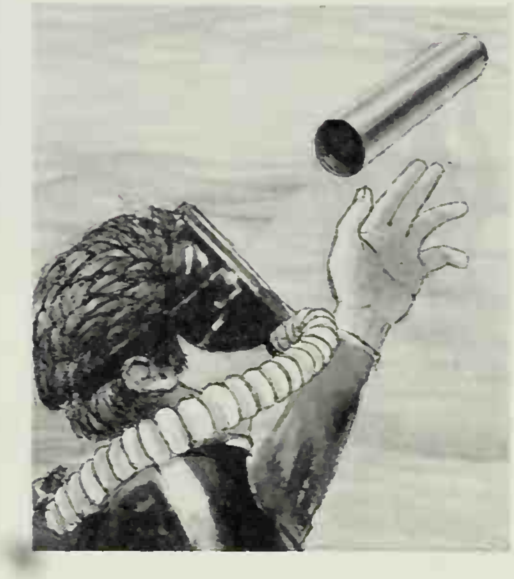
Left: Manoverboard marker attached to lifebuoy

Right: the Pen Series of distress signalling equipment

Below left: the Lifeline fires a line up to 274 metres (300 yards)

Below centre: the Frogman's underwater distress signal





Distress signals

Rockets, flares and markers

Manoverboard marker
The Pains-Wessex Manoverboard marker Series 2 provides a distress signal by day or night. When a lifebuoy, with the Manoverboard marker attached, is thrown into the sea, a large volume of orange smoke is emitted for 15–18 minutes and water activated batteries light two lamps, each of which gives a light output of 2 candela for over 45 minutes. The Manoverboard marker is made to withstand all weather conditions and is completely safe to operate on oil or petrol-covered water. It is used by the Royal Navy, approved by the British Board of Trade and complies with the SOLAS Convention.

Buoysmoke
The Buoysmoke is a daytime distress signal which, except that it has no lamps, is the same as the Manoverboard marker.

Coastal smoke
The coastal smoke signal is another variation of the Manoverboard marker, designed for small ships. It generates smoke for about 7 minutes. One version of the coastal smoke signal emits smoke only, another carries one 2-candela lamp of the type used on the Manoverboard marker.

Linethrowers
Both the Lifeline and Fisherman linethrowers are preloaded with a rocket and rot-proof line in a watertight case. Aiming and firing are easy and accurate. The maximum ranges are:
Lifeline: 274 m (300 yd)
Fisherman: 220 m (240 yd)

Frogman distress signal
This device is designed to enable a diver to give a signal to the surface from depths down to 30 m (100 ft). Before releasing the signal to float to the surface, the only operation required is to twist it free of its harness. When it reaches the surface the signal ignites a red flare that burns for 20 seconds.

Marine distress signals
The Pains-Wessex range of marine distress equipment is wide and comprehensive. It includes parachute rockets, smoke signals and flares as well as variety of kits which contain a selection of these. Approvals by the British Board of Trade and British Air Registration Board have been obtained where required.

Special signals for demonstrations and practice are also available.

Pen Series distress signals
The Pen Series is a convenient miniaturised version of the normal range of distress signalling equipment and is particularly suitable for use by aircraft and helicopters. To operate, it is only necessary to screw the required signal into a Pen gun, then pull back and release the trigger. The range of signals includes:

Ministar
There are two types, both of which eject red stars of 7500 candle power. In one type the star is ejected to a mean height of 60 m (200 ft) and burns for at least 5 seconds, in the other to over 90 m (300 ft) and burns for at least 5 seconds above 60 m (200 ft).

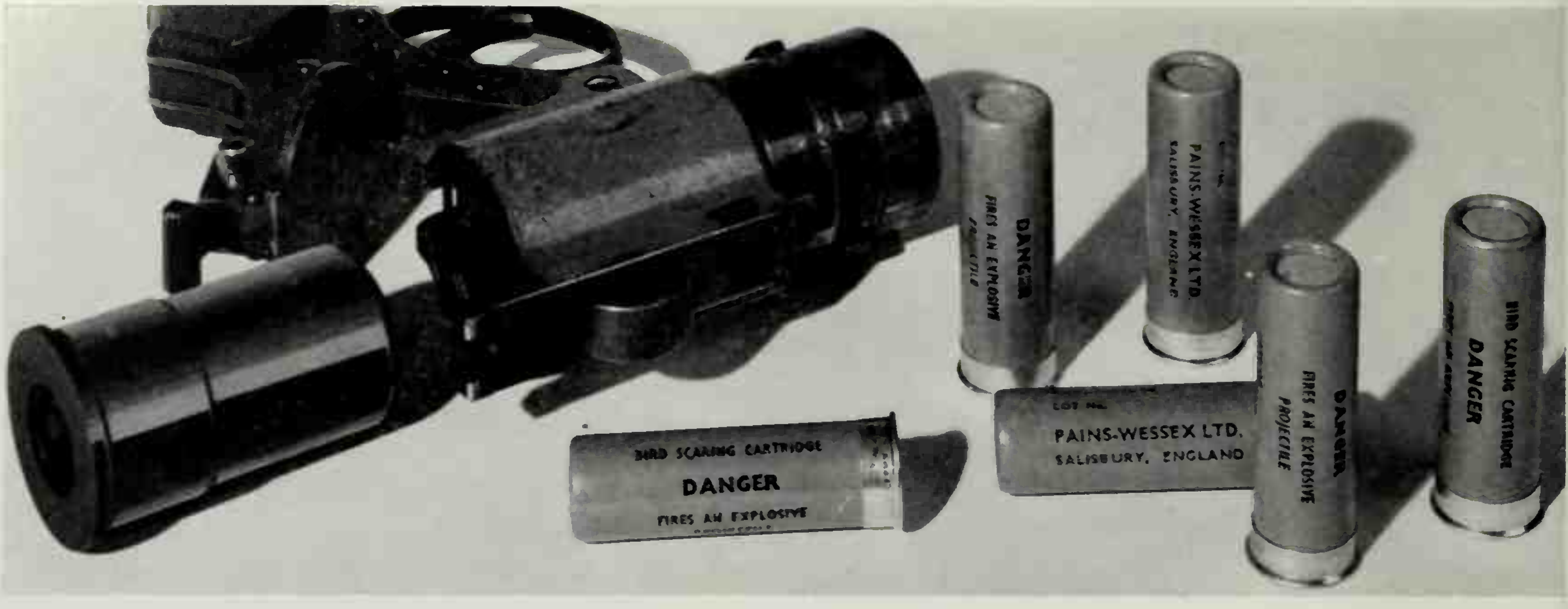
Mini 2 Star
Two red stars are ejected to a minimum height of 60 m (200 ft) and each burns for over 5 seconds with a candle power of 7500.

Pensmoke
The Pensmoke gives out a dense cloud of orange smoke for approximately 18 seconds. Used from a liferaft at sea, the signal can be seen by a helicopter from nearly 8 km (5 miles) distance in clear weather.

Penflare
The Penflare is the same size as the Pensmoke and has a red flare that burns for about 20 seconds at 15 000 candle power.

Penrocket
The Penrocket is percussion-ejected from its case before the motor ignites to carry it to over 300 m (1000 ft) when fired vertically. It then ejects two red stars which burn for 14 seconds.

PAINS-WESSEX LIMITED
High Post, Salisbury, Wiltshire, England
Telephone: Middle Woodford 282 Cables: Painwessex Salisbury


BIRD SCARING CARTRIDGE
DANGER
FIRES AN EXPLOSIVE
FIRES AN EXPLOSIVE PROJECTILE
LOT No.
PAINS-WESSEX LTD.
SALISBURY, ENGLAND

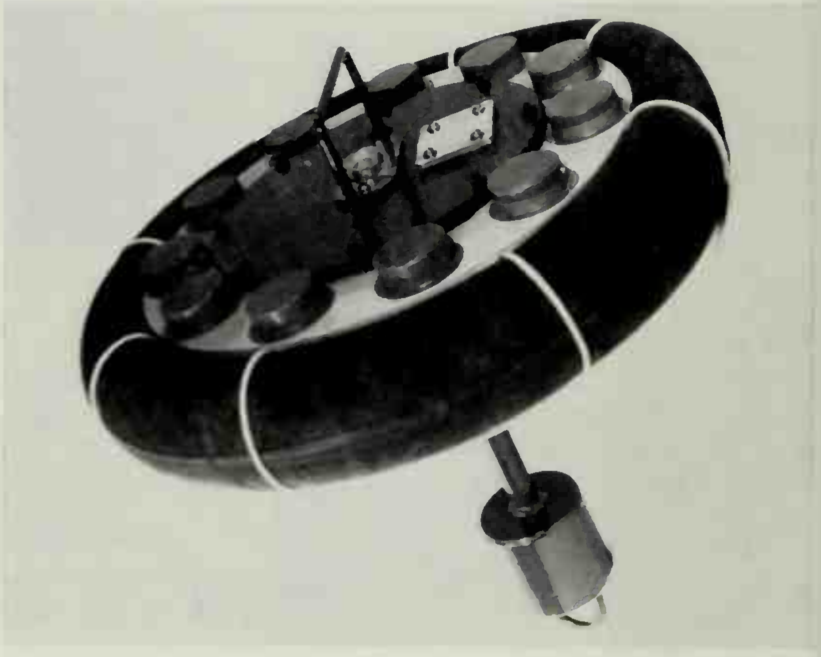
Above: bird-scaring cartridges with Very pistol showing the special liner

Right: hydrographic signal—tidal-flow marker

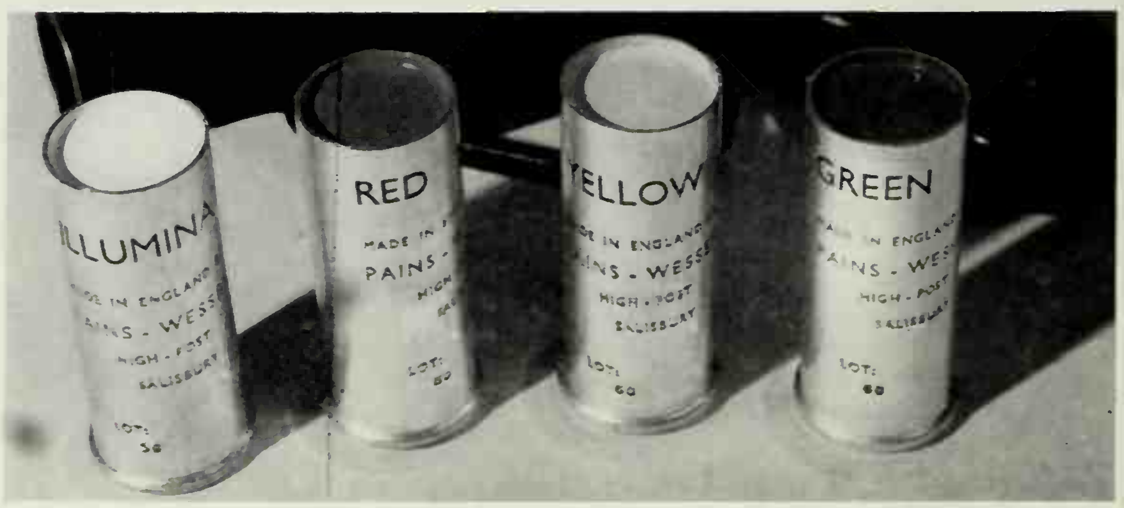
Right centre: parachutist's smoke tracer being used by the Falcons, the RAF parachute display team

Below: Oystersmoke marine marker can be dropped from a helicopter

Below right: Very pistol and cartridges



PAINS WESSEX


ILLUMINA
RED
YELLOW
GREEN
MADE IN ENGLAND
PAINS - WESS
HIGH - POST
SALISBURY
LOT:

Signal cartridges

Smoke and noise generators

Bird-scaring cartridges
The Pains-Wessex bird-scaring cartridges are used for driving birds from aircraft runways. They are filled in 12-bore cardboard cases, varnished for protection, and fired from a Very pistol fitted with a special liner. The cartridge ejects a projectile that emits a yellow trace before detonating in the air at the end of its flight. The range is about 90–150 m (100–160 yd). It is used by UK forces at home and abroad.

Hydrographic signal
This tidal-flow marker was specially designed to minimise the effects which wind and sea may have on it by giving it a freeboard of only 2 cm (0·8 in). It is normally fitted with 11 white smoke generators which are fired electrically at pre-set intervals and burn for about 1¼ minutes. A version for use at night carries an ionised xenon flashing light that has a light output of 50 000 candela.

Parachutist's smoke tracer
These smoke tracers are for use in free-fall displays by parachutists. They can be operated mechanically or electrically and give orange, yellow, green or blue smoke from 3600 m (12 000 ft). After a delay of 3 seconds they emit smoke for 45 seconds.

Oystersmoke
The Oystersmoke is designed to be dropped into the sea by a helicopter for marking a position or giving wind direction. The signal gives off a large volume of grey/white coloured smoke for 15–20 minutes. It can be dropped from 300 m (1000 ft) by a helicopter travelling at 60 knots.

Very cartridges
Aluminium is used for the cases of the 1·5-in Very cartridges and either aluminium or cardboard for the cases of the 1-in cartridges. These are filled to give a standard colour range of white, green and red, or a smoke puff.

Firesmoke
The Firesmoke signal produces a non-toxic white smoke for use in fire fighting and damage control exercises. It burns for approximately 1¼ minutes giving off a good volume of smoke.

Thunderflash
A wide range of Thunderflash devices varying in length from 12·7 cm (5 in) to 24·1 cm (9·5 in) give detonations from 100–150 decibels at 6·1 metres (20 ft). The larger types incorporate handles and break-off strikers and caps which cover the igniter composition.

Fumite insecticidal smoke generators
These consist of aluminium canisters filled with a non-explosive, non-flaming composition which, after ignition with a match, liberate clouds of insecticide particles. Suitable for messes, living areas and storehouses. The insecticides kill cockroaches, fleas, and insects in stored products. The generators are easily carried and can be operated by unskilled personnel.

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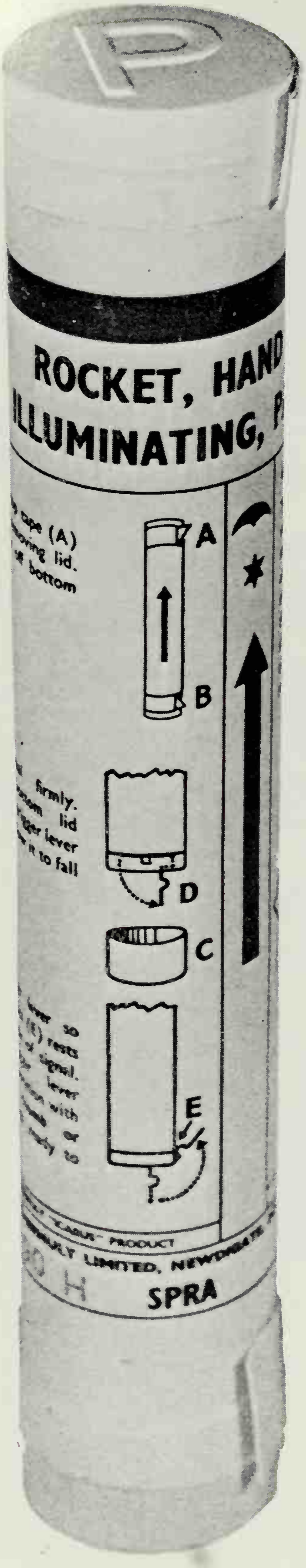
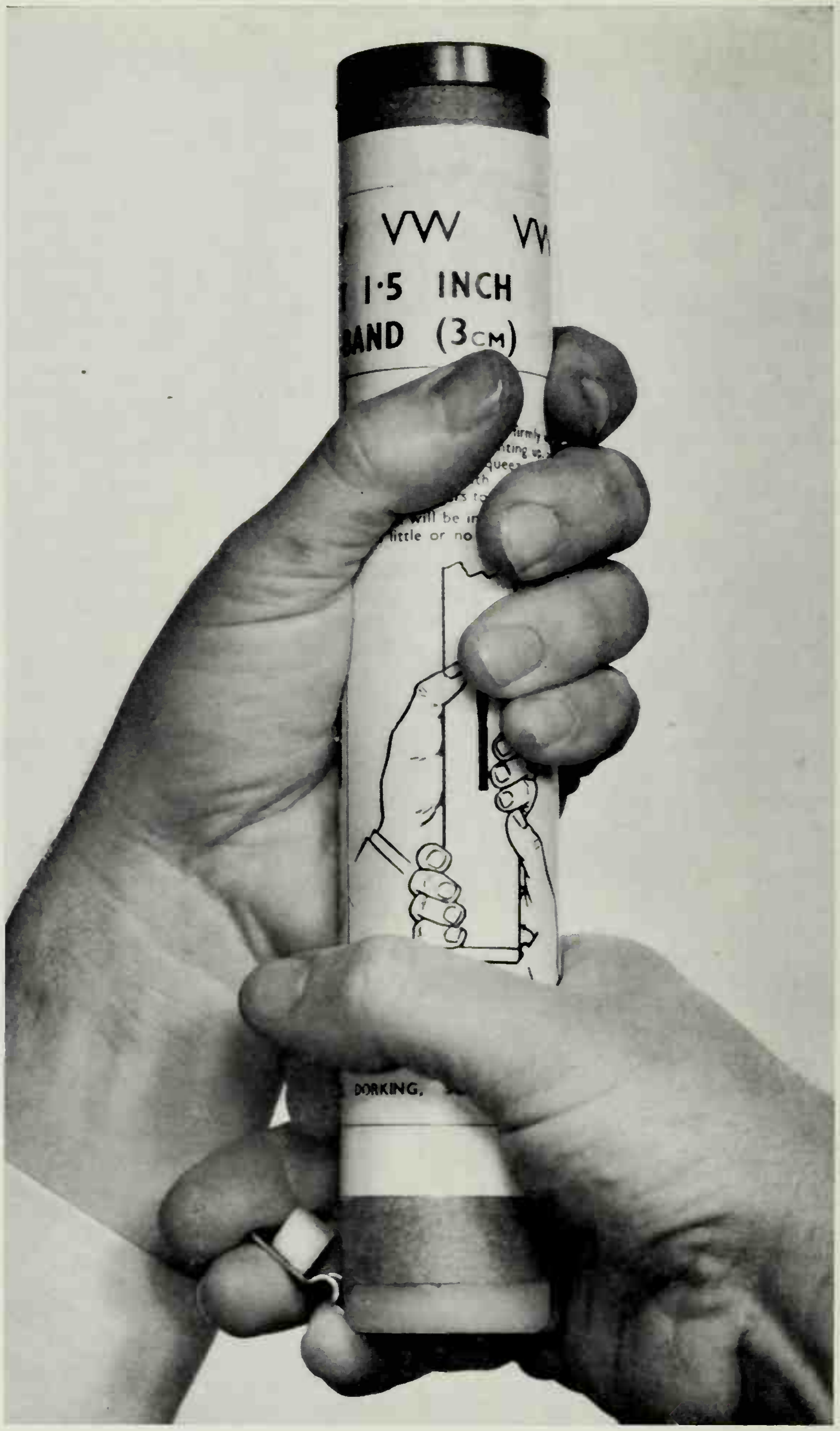
High Post, Salisbury, Wiltshire, England
Telephone: Middle Woodford 282 Cables: Painwessex Salisbury





Schermuly Icarus rockets

Whatever their payload, all Schermuly hand-held Icarus rockets are of the same basic design and construction. This includes a corrosion-resistant cylindrical discharger enclosing a seamless aluminium rocket with drum-type stabiliser, an ejection charge and a trigger-operated ignition device.

All Icarus rockets are designed to withstand rough treatment and the most severe climatic conditions, including several hours total immersion in water.

Standard packing is in multiples of 12 in a stout, waterproof polythene container with screw-top lid. Intensified climatic cycling shows that packed in this way a minimum shelf life of five years may be expected. The rockets have a length of 266mm (10·5in) a diameter of 44·5mm (1·8in) and weigh 365g (13oz).

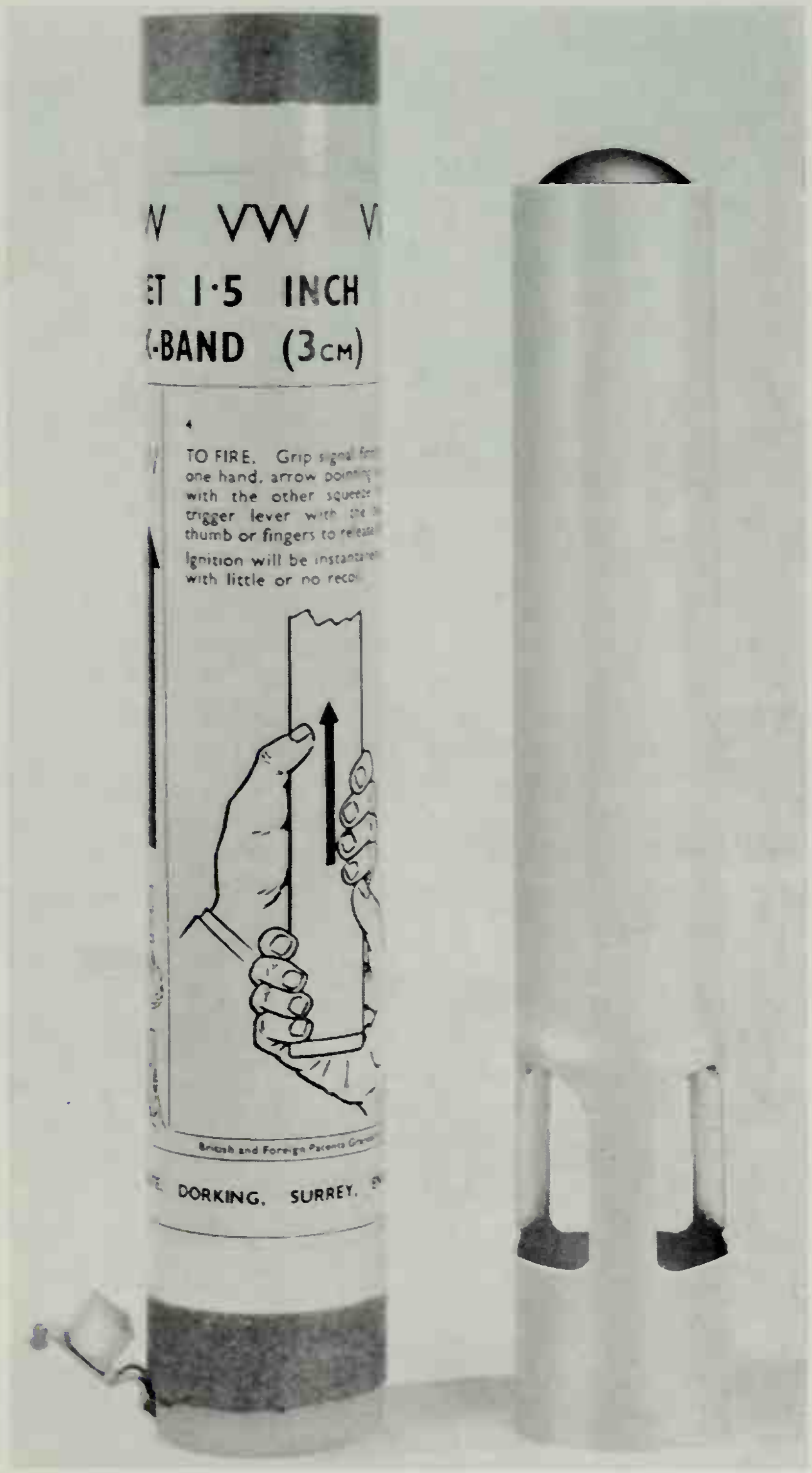
Pyrotechnic devices

Rocket illuminators, flares and signals

Schermuly was founded in 1897 by merchant seaman William Schermuly, the inventor of the first pistol-projected line-thrower.

During the Second World War the company was responsible for designing and producing a large proportion of the new and advanced pyrotechnic devices used by the Allied forces.

Schermuly now supplies service pyrotechnics to the British and Commonwealth naval, military and air services and to those in some 30 countries overseas.



Hand-fired illuminating rocket Para L3A1

This rocket, designed to Ministry of Defence requirements, is able to illuminate man-sized targets in silhouette at ranges between 90 and 365m (100 and 400yd), making possible accurate small arms fire at those ranges.

Slow spinning of the rocket ensures consistency in flight path, so that the flare may be accurately placed, and variations in elevation to suit the terrain are practicable.

Features specific to the illuminator are as follows:

Ground range 275–365m (300–400yd), dependent on elevation at launch
Illumination more than 80 000 candle power
Burning time more than 30sec
Average descent rate 4·75m/sec ($15\frac{1}{2}$ft/sec)

Hand-held rocket flares and signals

Apart from their payloads these parachute-type red, green and orange hand-fired distress signal rockets are identical to the illuminating rocket. Features common to these three types are as follows:

Height at which flare is released (fired vertically) 412m (1350ft).
Average descent rate 6·4m/sec (21ft/sec)

Flare data	*Red*	*Green*	*Orange*
Burning time, sec	40	35	40
Illumination, candle power	35 000	12 000	40 000

Other hand-held Icarus rocket signals

All the following signals are designed to be fired vertically or near vertically, and to eject their payloads at a height of 412m (1350ft).

(a) **Multi-star signals**
These rockets can carry up to four stars of 8–10sec burning time, in red, green or white.

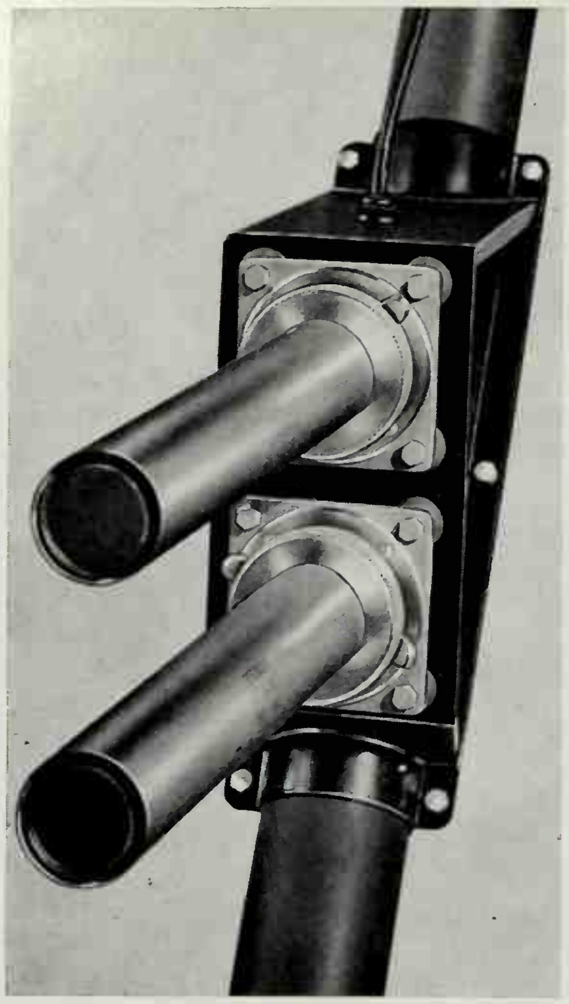
(b) **Smoke streamer**
This rocket ejects a free-falling generator which produces a vertical column of bright orange smoke, down to ground level.

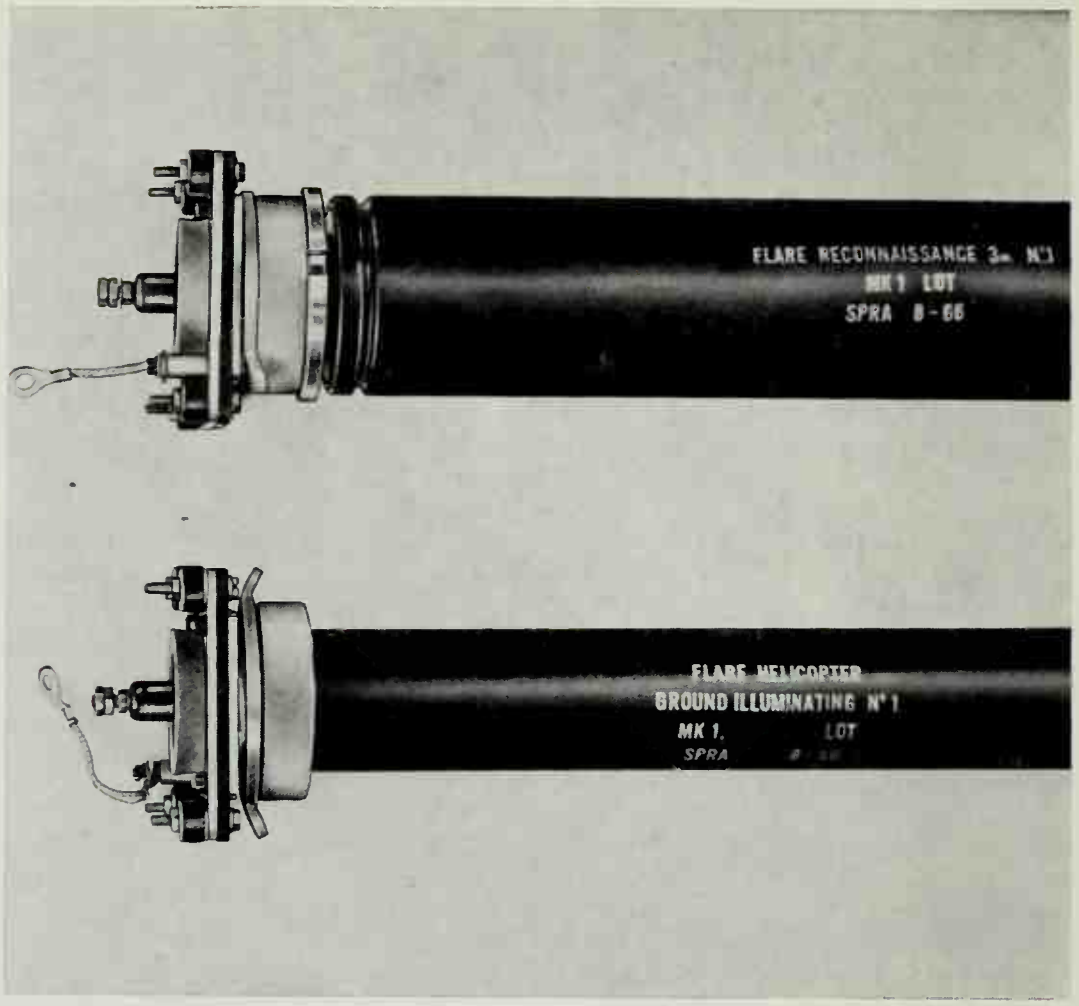
(c) **Radar reflective signals**
These Schermuly-Chemring rockets produce a reflective cloud which can be accurately detected by radar. The payload comprises packs of tuned dipoles varying in quantity according to the operating frequency and the particular application. The dipoles can be cut to resonate at frequencies in X, C or S bands as desired, and the size and duration of the echo obtained can be predetermined by a suitable choice of material.

(d) **Maroon**
This rocket ejects an explosive cartridge, producing a report which can be heard several miles away.

(e) **Parachute target**
This rocket ejects a brightly coloured 0·32m^2 ($3\frac{1}{3}$ft^2) parachute which has a very slow falling rate. It is used for the plotting of wind velocity and for gunnery practice.

SCHERMULY LIMITED
Spra Works, Newdigate, Dorking, Surrey, England
Telephone: Newdigate 331 Cables: Schermuly Dorking Surrey




FLARE RECONNAISSANCE 3in No 1
MK 1 LOT
SPRA 8-66
FLARE HELICOPTER
GROUND ILLUMINATING No 1
MK 1. LOT
SPRA

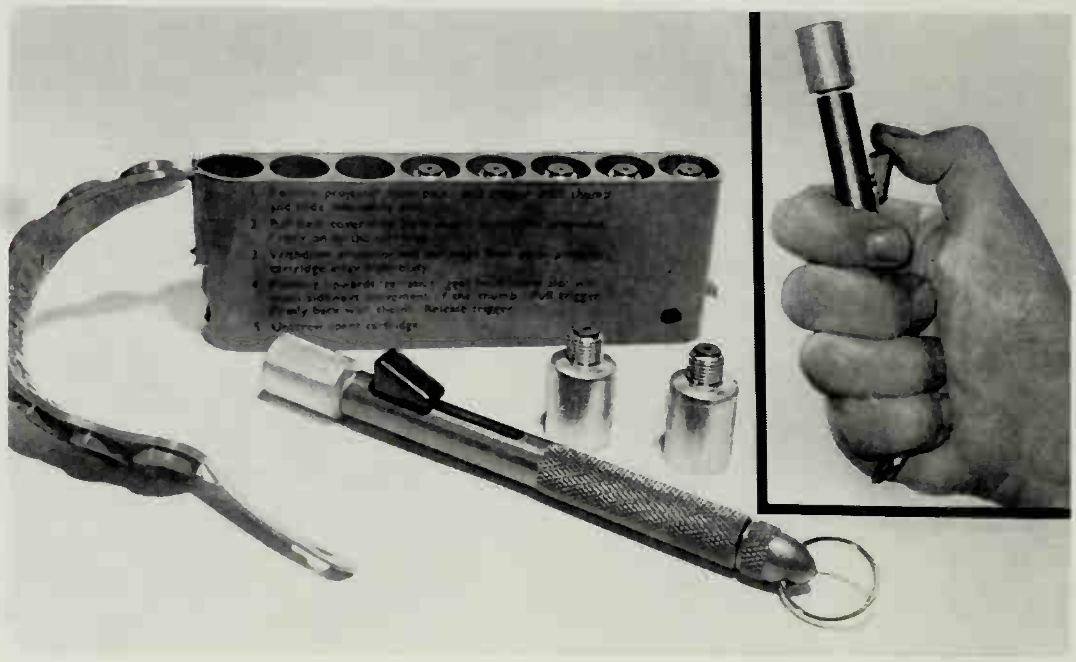
Above: Helicopter flares, showing method of mounting on undercarriage

Above right: Helicopter flares mounted on dischargers

Right: Miniflare with eight-cartridge container and (inset) shown in firing position

Below right: Red two-star distress signal Mk 4, showing compact size

Below: Firing the red night flare of the day and night distress signal No. 1 Mk 1



IGNITE THIS END
SIGNAL

PAT NOS 715865 736191
HOLD SIGNAL FIRMLY
AND AWAY FROM BODY
UNSCREW CAP

Pyrotechnic devices

Aircraft flares and distress signals

The equipment described below is designed and manufactured by Schermuly and fully meets the stringent requirements specified by the Ministry of Defence. It is freely available commercially.

Illuminators (airborne)

These long-burning, high-power flares for helicopters and light aircraft may be used for general illumination purposes, emergency landings at night or night reconnaissance. Available as standard equipment on Westland helicopters, they are in regular use on NATO, British and Commonwealth service machines as well as civil aircraft.

The flare units are mounted in multiples of two on dischargers attached either to the fuselage or to a member of the undercarriage. The flares are designed for electrical ignition and are fitted with wire bridge igniters requiring high electrical energy levels for operation, thus ensuring complete safety against inadvertent firing by induced currents.

Both the 54·5mm and 76·2mm (2·15 and 3in) flare units described below can be mounted on the same standard dischargers and with both units the parachute flares are ejected at least 15m (50ft) from the aircraft before they are ignited.

Characteristics

	Flare, Helicopter, Ground Illuminating, No. 1, Mk 2	*Flare, Helicopter, 3in Reconnaissance, No. 1, Mk 1*
British Service Reference	RN.365379 RAF.12D/1428	
Average illumination, candle power	180 000	300 000
Burning time, min	1½	2
Average descent rate, m/sec (ft/sec)	2·7 (9)	2·3 (7·5)
Size:		
Length, mm (in)	435 (17·1)	435 (17·1)
Diameter, mm (in)	54·5 (2·15)	76·2 (3·0)
Weight, g (oz)	1260 (47)	2720 (96)
Firing reaction impulse kg/sec (lb/sec)	2·15 (4·7)	3·58 (7·9)

Red 2-Star Distress Signal, Mk 4

This signal is designed and constructed to military standards, and consists of an extruded aluminium case with threaded cap which contains two red stars which are ejected at intervals after operation of the percussion ignition system.

Leading data

Length 124mm (4⅞in)
Diameter 28·6mm (1⅛in)
Weight 155g (5½oz)
Flare burning time 6–7sec
Light output 7000 candle power
Height of ejection 61m (200ft)

Buoyant 1½in Yellow Smoke Cartridge (RAF ref. 12D/1382)

This cartridge ejects a payload which emits bright yellow smoke. The cartridge is fired from a standard 38mm (1½in) signal pistol, and is used from helicopters and light aircraft to indicate wind direction and for height judgement. It is buoyant, so can be used over water as well as land, including snow-covered terrain.

An identical cartridge is available commercially under the description 'Cartridge, 1½in, Wind Indicating'.

Leading data

Diameter 39·1mm (1·54in)
Length 158mm (6¼in)
Weight 170g (6oz)
Delay time 8–10sec
Burning time 20–25sec

Day and Night Distress Signal No. 1 Mk 1 (RAF ref. 12D/1276)

This combined smoke and flare signal is made to Ministry of Defence specification and is NATO approved. One end generates dense red/orange smoke and the other end houses a red flare. Each portion is independently operated by a percussion igniter, and the signal is completely waterproof.

Leading data

Length 133mm (5¼in)
Diameter 38mm (1½in)
Weight 205g (7¼oz)
Smoke burning time 18sec
Flare burning time 20sec
Flare light output 18 000 candle power

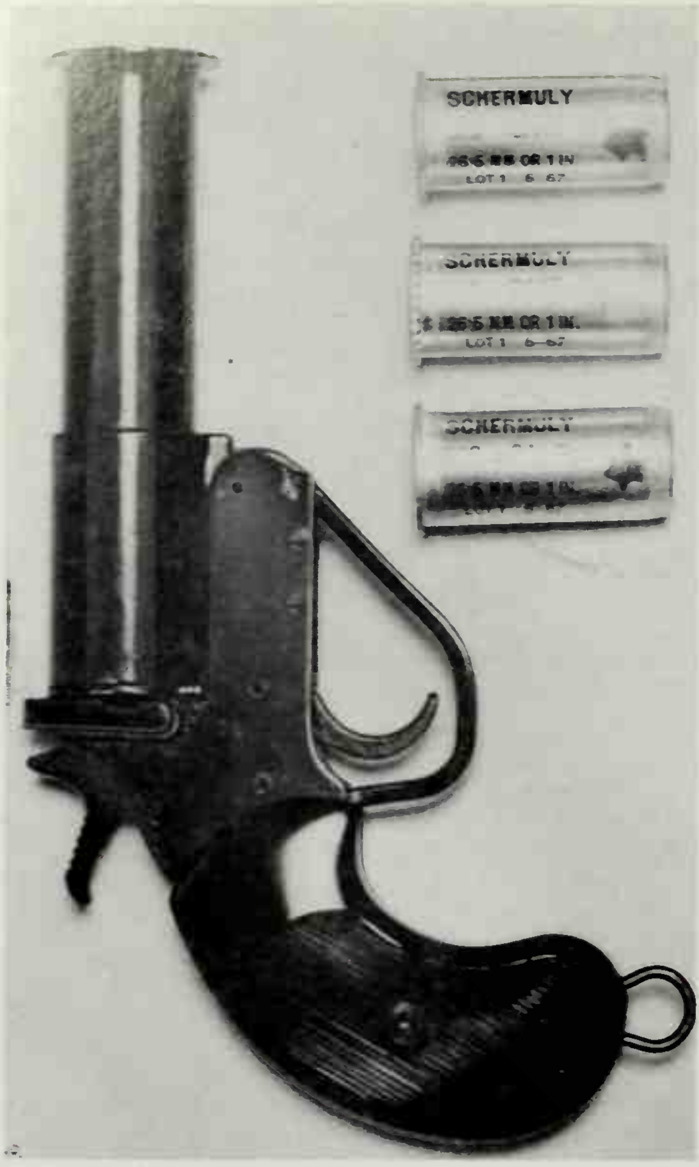
Miniflare

A complete Miniflare kit consists of a projector and eight cartridges stowed in an easily opened plastic pack measuring only 152 × 63 × 19mm (6 × 2½ × ¾in) and weighing 255g (9oz). The flares are suitable for medium-range signalling purposes and for distress signalling. A special feature is the ease with which the flares can be removed from the package and fired from the pen-sized, spring-loaded projector, with one hand only if necessary.

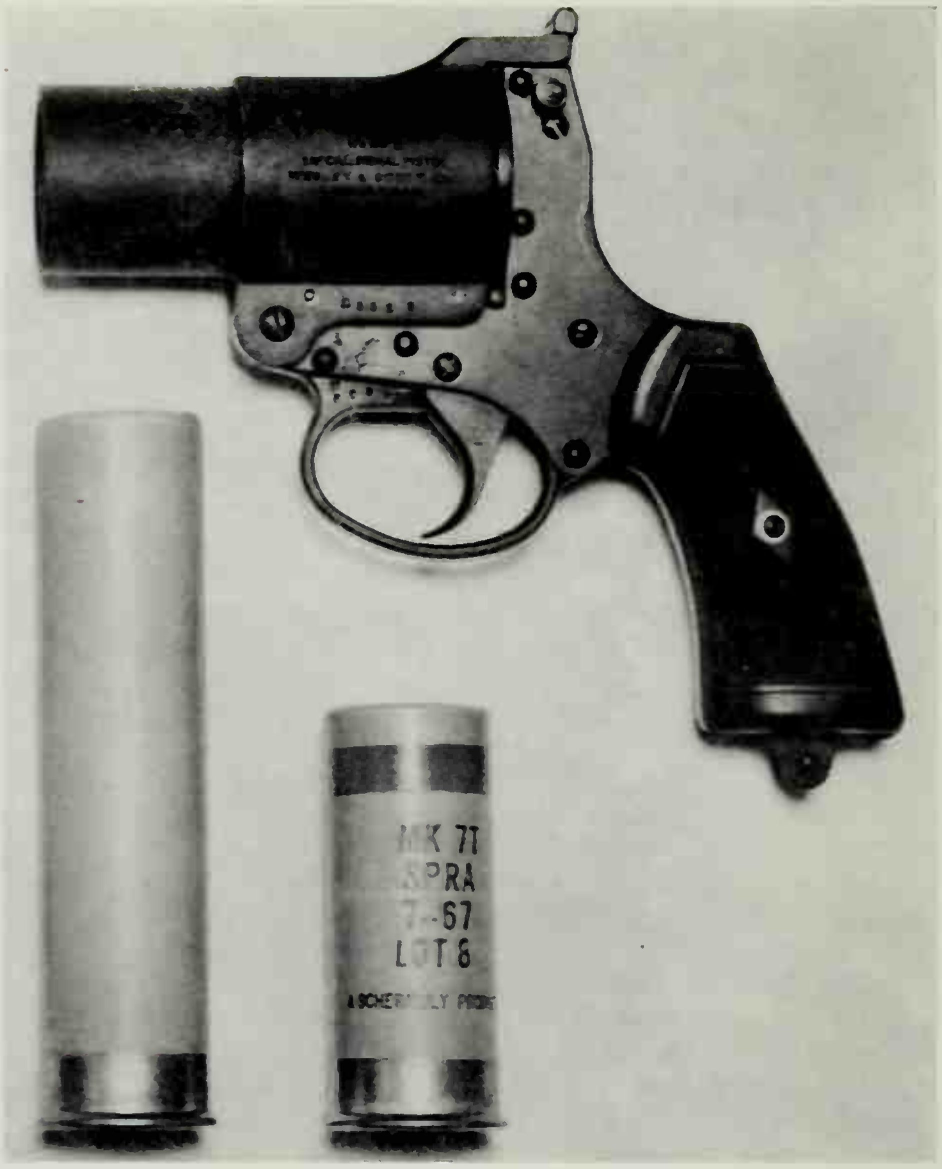
Features of the flares are as follows:

Colours red, green and white/illuminating
Burning time 6–7sec
Height of trajectory 91m (300ft)

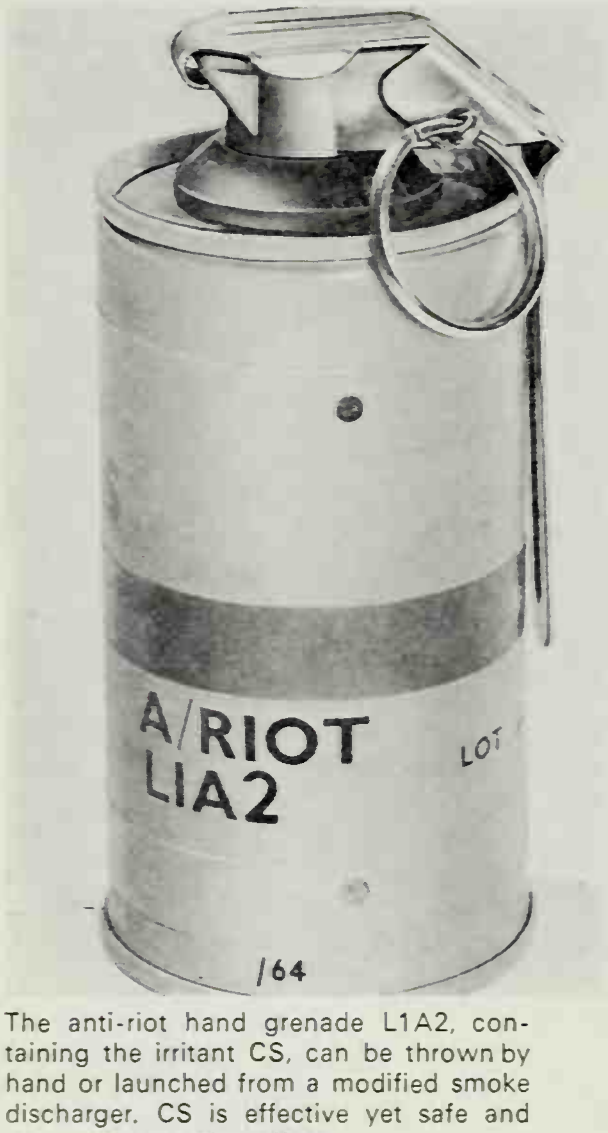
SCHERMULY LIMITED
Spra Works, Newdigate, Dorking, Surrey, England
Telephone: Newdigate 331 Cables: Schermuly Dorking Surrey


SCHERMULY
26·5 MM OR 1 IN
LOT 1 6 67
SCHERMULY
26·5 MM OR 1 IN.
LOT 1 6-67
SCHERMULY

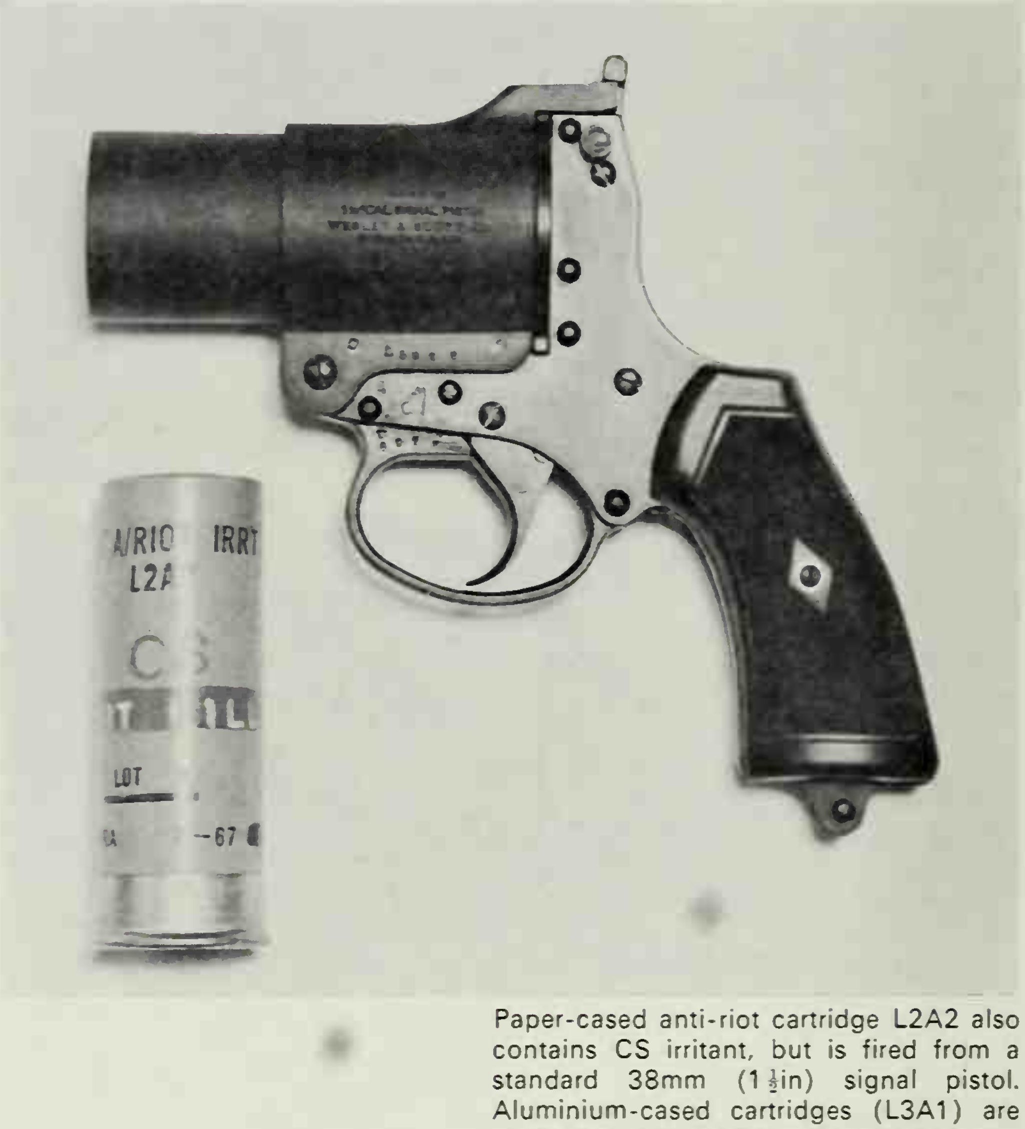
26·5mm (1in) signal pistol with aluminium-cased cartridges to produce red, green or illuminating/yellow flares for 6–8sec at a height of almost 100m (300ft)


MK 7T
SPRA
7-67
LOT 8
SCHERMULY PRODUCT

Smoke puff signal cartridges with suitable 1½in signal pistol. The white smoke puff cartridge is shorter; the longer cartridge produces a brown smoke puff


A/RIOT
LIA2
LOT
/64

The anti-riot hand grenade L1A2, containing the irritant CS, can be thrown by hand or launched from a modified smoke discharger. CS is effective yet safe and produces no lasting effects


A/RIO IRRT
L2A
CS
LOT
-67

Paper-cased anti-riot cartridge L2A2 also contains CS irritant, but is fired from a standard 38mm (1½in) signal pistol. Aluminium-cased cartridges (L3A1) are similar but designed for use in riot guns

It is to be noted that all smoke-producing elements—including riot control equipment—can be injurious to the person if used in confined spaces. Appropriate precautions should therefore be taken.

Pyrotechnic devices

for signalling and riot control

Signalling equipment

Signal cartridges, 1in and 1½in

These newly developed aluminium-cased cartridges are of a quality comparable to that of cartridges made for the British Government. These are two sizes: the 26·5mm (1in) cartridge can be fired from a standard 1in or a calibre 4 signal pistol; the 38mm (1½in) cartridge from a 38mm (1½in) signal pistol. The 26·5mm cartridge is 55mm (2·165in) long, the 38mm cartridge is 87·6mm (3·45in) long.

Features

Colours: red, green, illuminating/yellow
Burning time: 6–8sec
Trajectory height: 91m (300ft)
Pack: 26·5mm cartridges in units of 10 per colour, 38mm cartridges in units of 50 per colour

Smoke puff signal cartridges

Both the 38mm (1½in) brown smoke puff Mk 4T (RAF ref 12D/1418) and the 38mm (1½in) white smoke puff Mk 4T signal cartridges are of paper-cased type and made to Ministry of Defence specification. They produce a report and a ball of smoke at a height of at least 30m (100ft), for signalling or for measuring wind velocity.

Features	*Brown*	*White*
Length mm(in) ..	160 (6·3)	97·8 (3·85)
Dia mm(in)	39·1 (1·54)	39·1 (1·54)
Weight g(oz)	227 (8)	120 (4¼)

Smoke grenades

These are designed for ground-to-air signalling and for ground marking. They produce a dense cloud of red, green, yellow or blue smoke. Ignition is by percussion igniter and delay fuse which allows them to be tossed down-wind before smoke generation starts.

Features

Dimensions: 54mm dia × 92mm (2½ × 3⅝in)
Burning time: 10–25sec
Delay time: 2–3½sec
Weight: 185g (6½oz) approx
Packed in units of 30 per colour

SCHERMULY
SMOKE GRENADE
RED
1 REMOVE SCREW CAP
2 PULL & TWIST OFF D RING
3 THROW GRENADE IMMED

Riot control equipment

Schermuly manufactures under licence the British Government anti-riot stores that generate clouds of smoke, containing the irritant CS.

Compared with the hitherto more widely used tear gas CN (CAP), CS is effective at much lower concentrations and results in less severe after-effects. The equipment is designed to function with no risk of fragmentation, and with minimal fire risk. The effects resulting from exposure to CS pass off within a few minutes of removal from the contaminated area, providing humane means of controlling rioters or law breakers.

These devices are capable of being stored for many years anywhere in the world, with a high probability of satisfactory functioning.

Anti-riot 1½in cartridges L2A2 and L3A1

The first of these cartridges is a paper-cased store designed primarily for firing from standard 38mm (1½in) signal pistols, and the second is an aluminium-cased store carrying a larger payload designed for firing from all types of anti-riot gun.

Features	*L2A2 Cartridge (paper)*	*L3A1 Cartridge (aluminium)*
Range (lobbed)	69–91m (75–100yd)	119m (130yd) approx.
Range (aimed 20cm (8in) square group)		50m (45yd)
Delay time, sec	2–3	2–3
Burning time, sec	5–25	5–25
Length, mm (in)	107 (4·2)	122 (4·82)
Diameter, mm (in)	39·1 (1·54)	38·71 stepped to 39·57 (1·524–1·558)
Weight, g (oz)	135 (4¾)	200 (7)
Packaging	seven per sealed tin six tins per ammunition box, C364	

Anti-riot hand grenade L1A2

This store can either be thrown by hand or launched from a modified smoke discharger on armoured cars.

Features

Range about 32m (35yd) when thrown, 64–110m (70–120yd) when fired from discharger
Burning time 10–40sec
Delay time 2–3sec
Length 140mm (5½in)
Diameter 63·5mm (2½in)
Weight 454g (16oz)
Packaging 10 per ammunition box, M104

Hand-held irritant generator L1A1

This generator is designed primarily as a training aid. It produces a comparatively low concentration of smoke for 3½–5½ minutes, permitting respirator training under realistic conditions.

The composition is contained within a cylinder 425mm (16¾in) long by 25·4mm (1in) dia, fitted with a handle.

Initiation is by means of a friction igniter stored within the handle.

Irritant smoke pellet for respirator testing

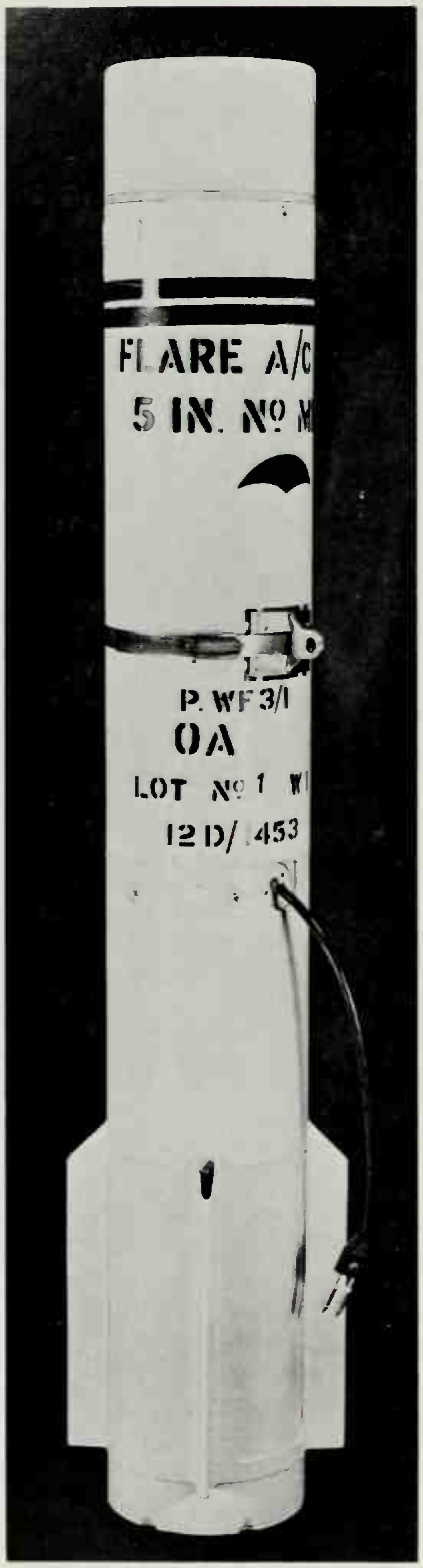
As the name implies these pellets are used for testing the fit of respirators. They are ignited by means of a match fuse singly or in multiples as required.

They weigh 1g (1/30oz) and burn for 8–25 sec.

SCHERMULY LIMITED
Spra Works, Newdigate, Dorking, Surrey, England
Telephone: Newdigate 331 Cables: Schermuly Dorking Surrey

Reconnaissance flare

for fixed-wing aircraft



Developed to meet the Royal Air Force requirement for an air-dropped parachute flare that is suitable for both reconnaissance and battlefield illumination purposes, the 127-mm (5-inch) reconnaissance flare has superseded all other aircraft flares by virtue of its advanced design and superior performance.

Pre-flight preparation is kept to a minimum, requiring only a circuit check and fuze setting.

The aluminium alloy hardware ensures a long storage life and high tolerance of severe physical and environmental conditions. Major components are self-contained and sealed.

The 127-mm (5-inch) reconnaissance flare is made safe in storage, handling and use by virtue of the inherent safety devices. A model suitable for release from helicopters may be available shortly.

Specification

Safety features
Integral radio-frequency attenuator
Fail-safe fuze-arming system
Parachute deployment delay

Carriage
Subsonic: light series carrier (e g Mk 15)
Supersonic: ML light stores carrier No 100

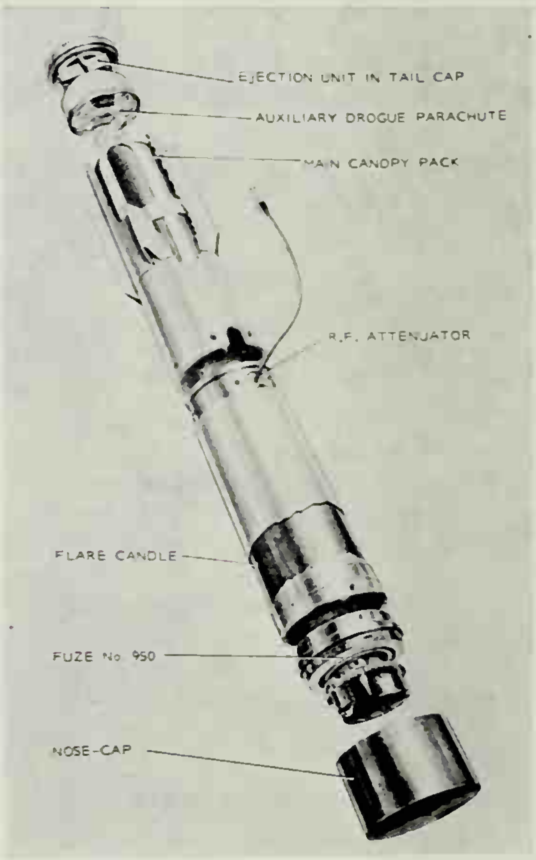
Performance
Burning time: 3·25–3·5 min
Light intensity: 1 000 000 candela minimum

Parachute system
Twin, 3·35 m (11 ft) dia canopy parachutes, mainly in nylon, pressure-packed, fitted with drogue auxiliary

Dimensions
Overall length: 914 mm (36 in)
Overall diameter: 178 mm (7 in)
Body diameter: 127 mm (5 in)
Weight: 16·33 kg (36 lb)

Operational delays
Fuze setting tolerance: 8–60 sec
Parachute deployment and arming delay: 3·5 sec

Rate of descent
Unlit: 305 m/min (1000 ft/min)
Flare burning: 183 m/min (600 ft/min)



Wallop Industries Limited has been concerned with the development and manufacture of a wide range of sophisticated pyrotechnic devices for defence, space and industrial projects for over twenty years.

The company has available research, development and design facilities, as well as production plant able to undertake quantity and batch manufacture of pyrotechnic devices, also the production of models and prototypes. In addition to the 127-mm (5-inch) reconnaissance flare, current production items include missile tracking flares, high-accuracy delay elements, rocket ignition systems, pyromechanical actuators and other devices.

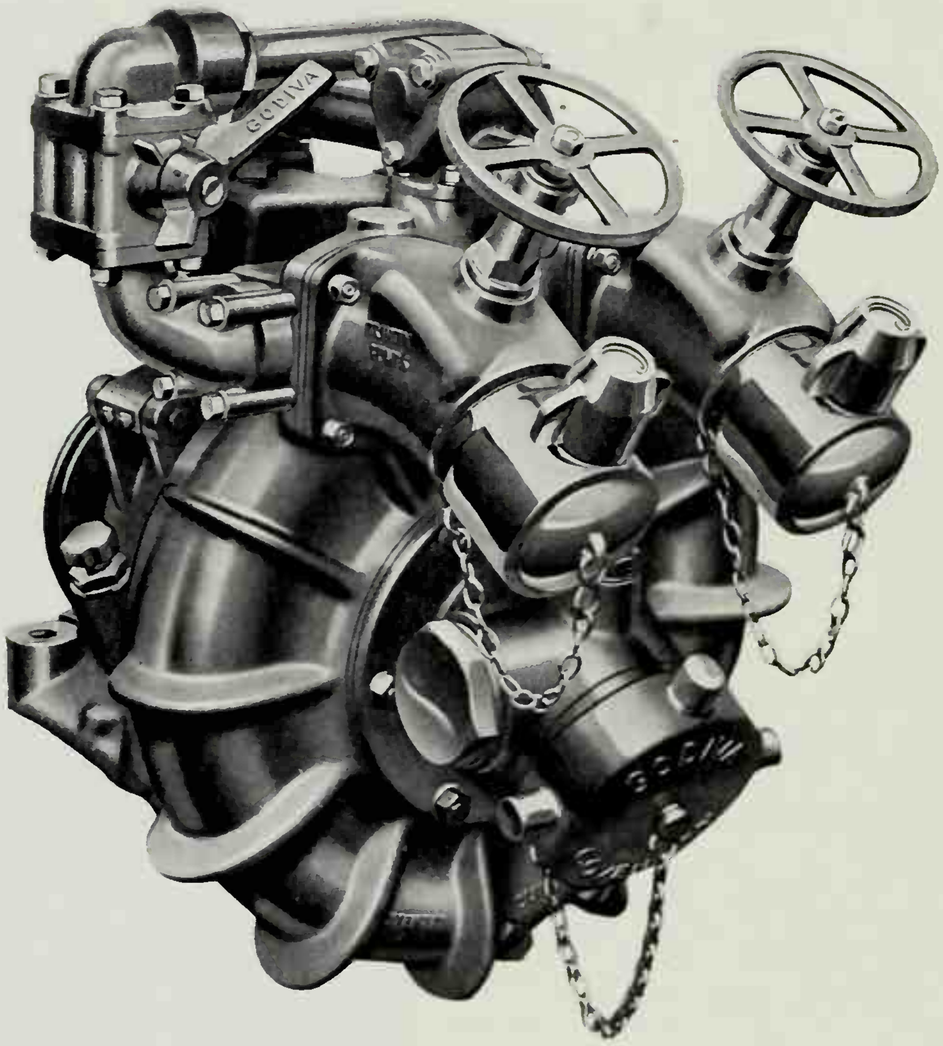
A company brochure is available on request.

WALLOP INDUSTRIES LIMITED
Middle Wallop, Stockbridge, Hampshire, England
Telephone: Wallop 456 Telex: 47692

Section 31

Fire fighting equipment

Godiva fire pumps are manufactured by Coventry Climax Engines Ltd, a firm which has over 60 years' experience of engine manufacture. A range of fast-into-action fire pumps second to none has been produced since 1937. For many years, these portable vehicle-mounted and trailer fire pumps have been specified as standard equipment by British military and civil fire services. They are also in use by many overseas forces.

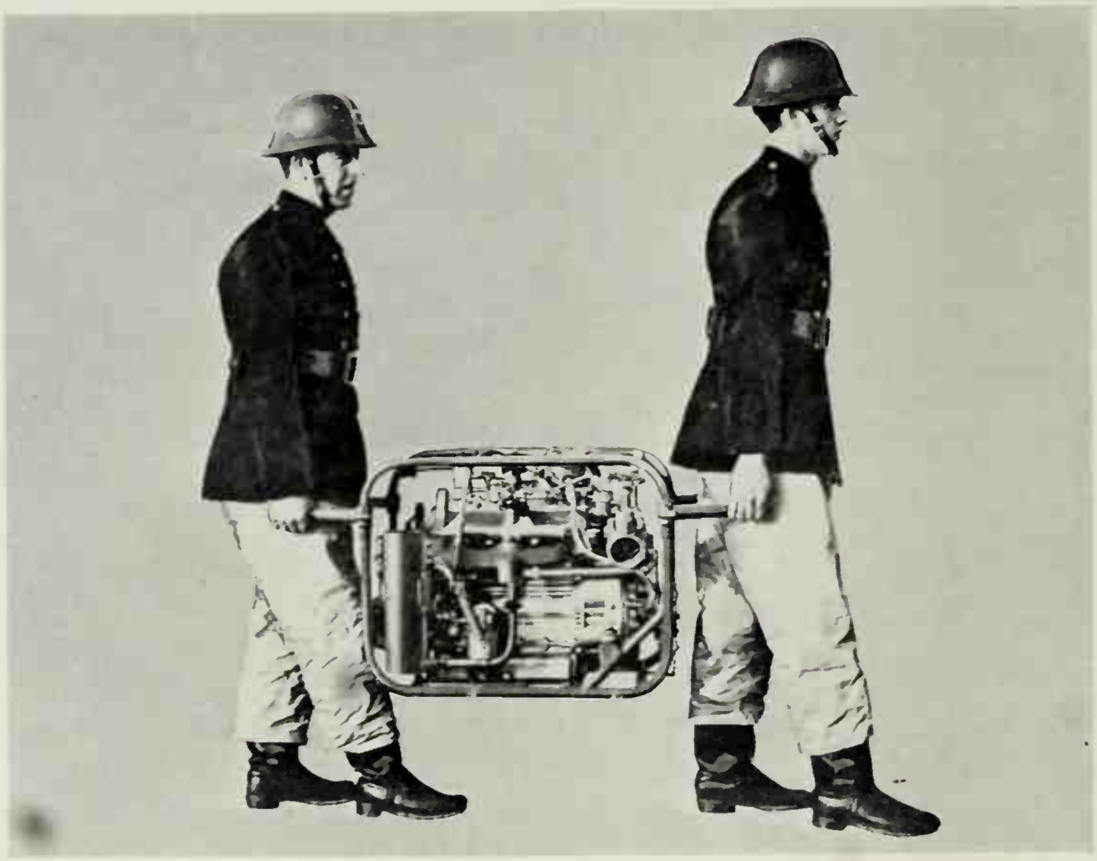


UMP

Multi-pressure two-stage vehicle-mounted fire pump. This unique pump provides: operating pressures up to 42·2 kg/cm^2 (600 lb/in^2); low pressure outputs up to 4500 litres/min (1000 gal/min); low pump speeds to give long seal and bearing life; low power requirements capable of being met by the smallest engines used in fire appliance chassis; facility to function on low and high pressure simultaneously; compact dimensions; simple operating technique and reliability.

FWMP

A portable centrifugal single-stage pump, completely self-contained and exceptionally light. Fully fuelled, the pump weighs only 113 kg (250 lb) and can be easily carried by two men. On certain models of portable pumps full electric starting is available for instantaneous service.



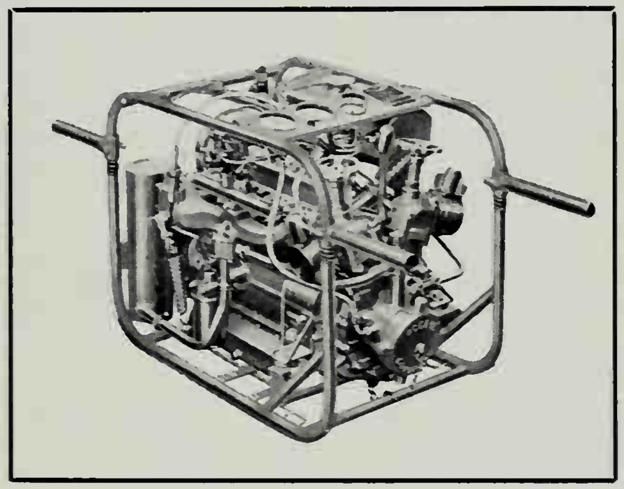
Fire pumps

portable, trailer and vehicle-mounted

Portable pumps

Easily handled by two men, Godiva portable fire pumps are the complete answer where water is needed quickly in positions inaccessible to a fire tender. Powered by race-proved Coventry Climax overhead camshaft engines and constructed in corrosion-resistant light alloy, Godiva pumps are available with outputs up to 2273 litres/min (500 gal/min) and pressures up to 17·6 kg/cm^2 (250 lb/in^2).

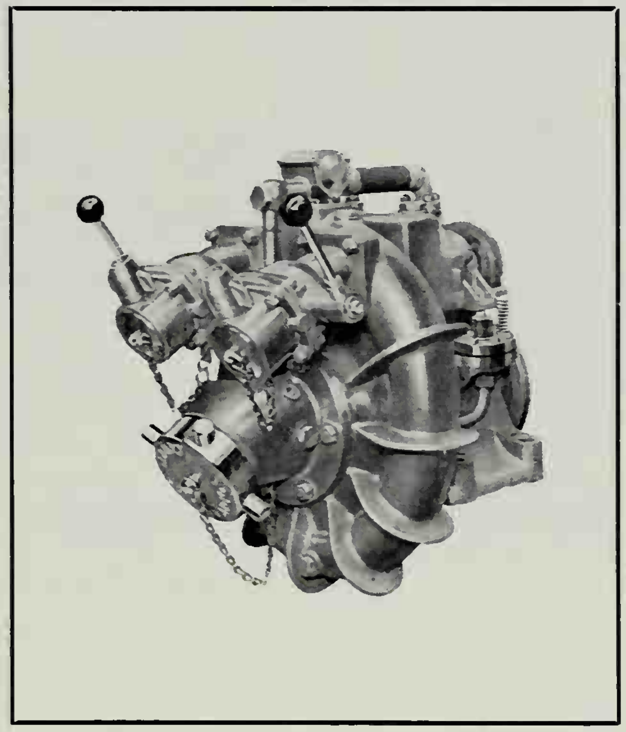
Type	Engine	Output at 7 kg/cm^2 (100 lb/in^2)		Operational weight	
		litres/min	gal/min	kg	lb
FWMP	Petrol	1136	250	113·4	250
FWHP	Petrol	386 at 17·6 kg/cm^2	85 at 250 lb/in^2	113·4	250
FWP	Petrol	1364	300	165·5	365
FWBP	Petrol	2273	500	215·4	475
FWMDP	Diesel	796	175	145·1	320



Vehicle-mounted pumps

The Godiva range of vehicle-mounted pumps includes models suitable for any make of fire appliance chassis and for front, rear or amidships mounting. Deliveries go up to 5455 litres/min (1200 gal/min) and a multi-pressure version is available which operates on a hose reel system at 42·2 kg/cm^2 (600 lb/in^2).

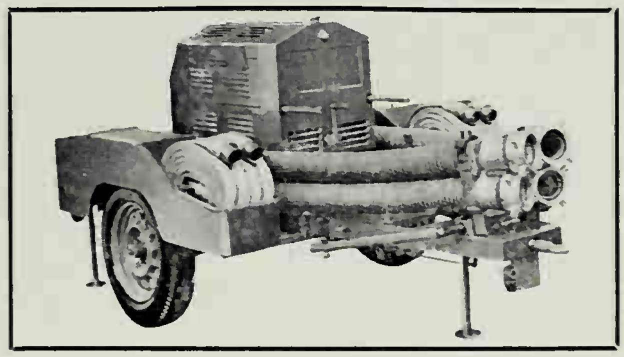
Type	Where mounted	Performance
UMP multi-pressure	Rear or amidships	*Low-pressure stage:* 2270, 3410 and 4550 litres/min at 7 kg/cm^2 (500, 750 and 1000 gal/min at 100 lb/in^2) *High-pressure stage:* 192 litres/min at 42·2 kg/cm^2 (45 gal/min at 600 lb/in^2)
UFP range	Rear or amidships	Deliveries up to 5455 litres/min and pressures up to 15·5 kg/cm^2 (1200 gal/min and 220 lb/in^2)
UHP dual-pressure	Rear or amidships	3409 litres/min at 7 kg/cm^2 and 227 litres/min at 31·6 kg/cm^2 (750 gal/min at 100 lb/in^2 and 50 gal/min at 450 lb/in)
FWPS	Rear or amidships on light vehicles	1364 litres/min at 7 kg/cm^2 (300 gal/min at 100 lb/in^2)
ACP	Front of appliance	2273 litres/min at 7 kg/cm^2 (500 gal/min at 100 lb/in^2)



Trailer pumps

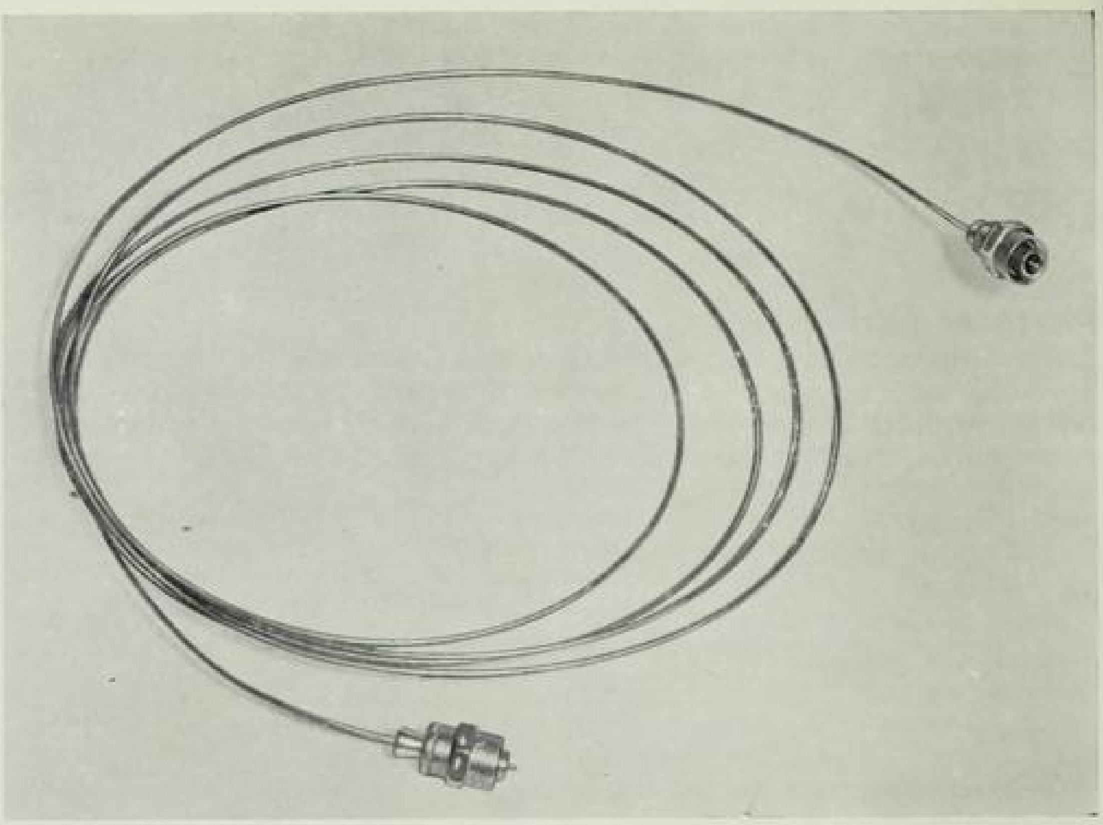
Godiva trailer-mounted pumps are available in two sizes, with a performance up to 2273 litres/min (500 gal/min) at 7 kg/cm^2 (100 lb/in^2). Bonneted, and with their own wheels, they are mounted on trailers which also hold suction and delivery hose and equipment. Any car or light vehicle can tow the loaded trailer without difficulty.

Type	Engine	Output at 7 kg/cm^2 (100 lb/in^2)		Dry weight	
		litres/min	gal/min	kg	lb
TFW	Petrol	1364	300	454	1000
TFWB	Petrol	2273	500	463	1020

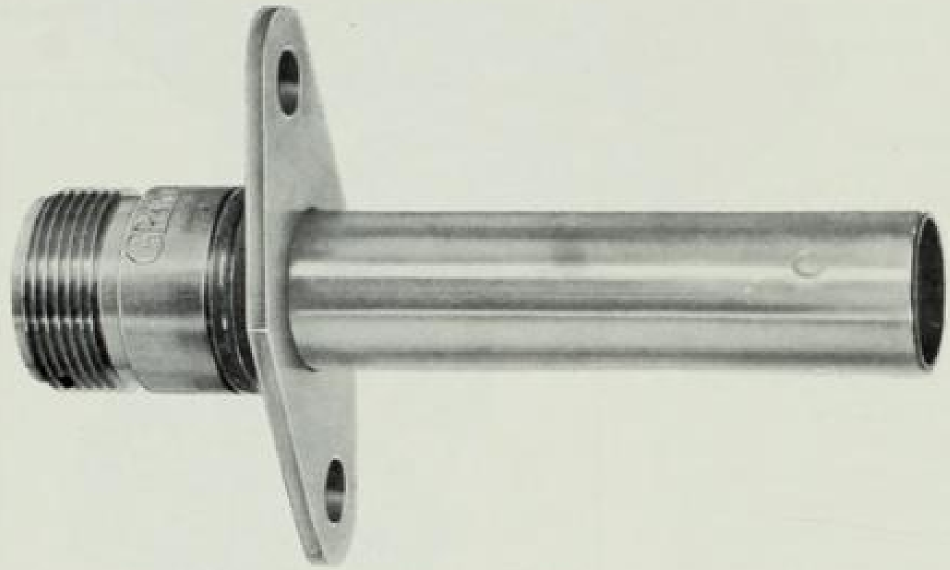


COVENTRY CLIMAX ENGINES LTD
Military Sales Division
Berkeley Square House, Berkeley Square, London W1, England
Telephone: 01-499 6050   Cables: Leymotors London W1 Telex   Telex: 22498

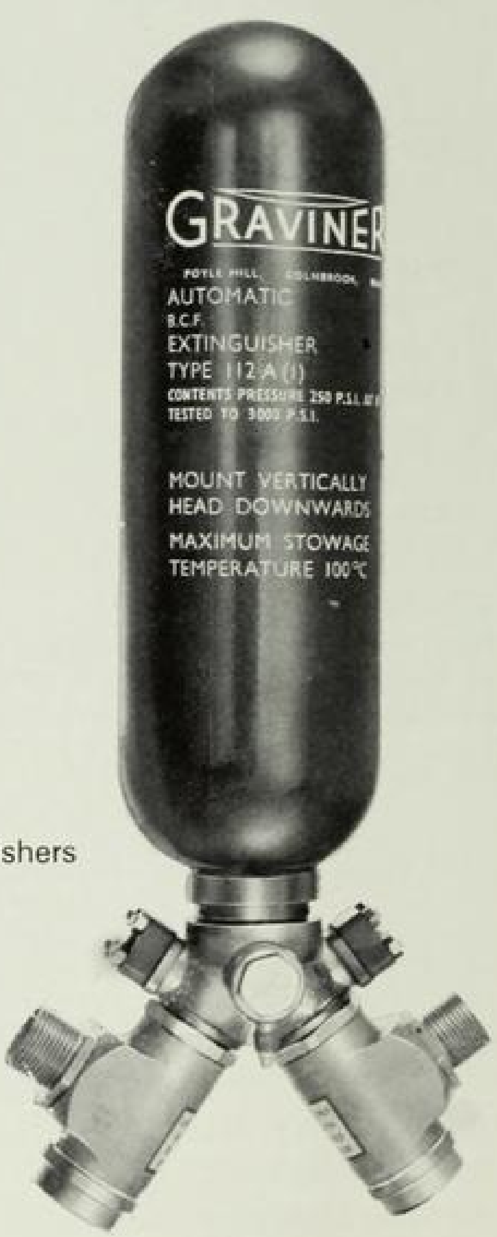
BRITISH
LEYLAND



Firewire Triple FD continuous resetting detector



Single-point resetting detector switches


GRAVINER
AUTOMATIC
B.C.F.
EXTINGUISHER
TYPE 112 A (1)
TESTED TO 3000 P.S.I.
MOUNT VERTICALLY
HEAD DOWNWARDS
MAXIMUM STOWAGE
TEMPERATURE 100°C

Fire extinguishers

Fire-protection equipment

for automatic and manual operation

Firewire Triple FD continuous resetting detector

Designed to detect and give warning of fire or overheat conditions, the Graviner Firewire Triple FD system employs continuous-type detectors, is resetting and is unique in that it discriminates between a true warning and a system fault.

Experience has shown that the principal cause of false warnings is damage—usually the result of maltreatment during maintenance—to the sensing elements. Employing a completely new principle of operation, the Firewire Triple FD system will not signal a warning if a short circuit occurs as a result of element damage or a fault in the wiring between the element loop and the control unit.

An extensive range of sensing elements and control units is available to enable the system to be engineered specifically to suit the requirements of virtually any known application, and in particular to cater for any current or future type of aircraft, ship, fighting vehicle or hovercraft.

Single-point resetting detector switches

These unit-type, thermally operated, resetting fire and overheat detector switches are approved for use in potential fire zones and are currently fitted as standard equipment to a wide range of aircraft, diesel-engined locomotives, ships, fighting vehicles and hovercraft.

The temperature-sensitive element comprises an alloy-steel barrel with a high coefficient of expansion, containing a spring bow assembly of low expansion coefficient on which are mounted two electrical contacts. Expansion of the barrel due to rise in temperature progressively relaxes the compressive force on the bows until, at the preset operating temperature, the electrical contacts close. A return to normal temperatures reopens the contacts and automatically resets the switch. These robust switches can withstand high ambient temperatures and severe environmental conditions, and a comprehensive series of switches is available to cover a wide range of operating temperatures.

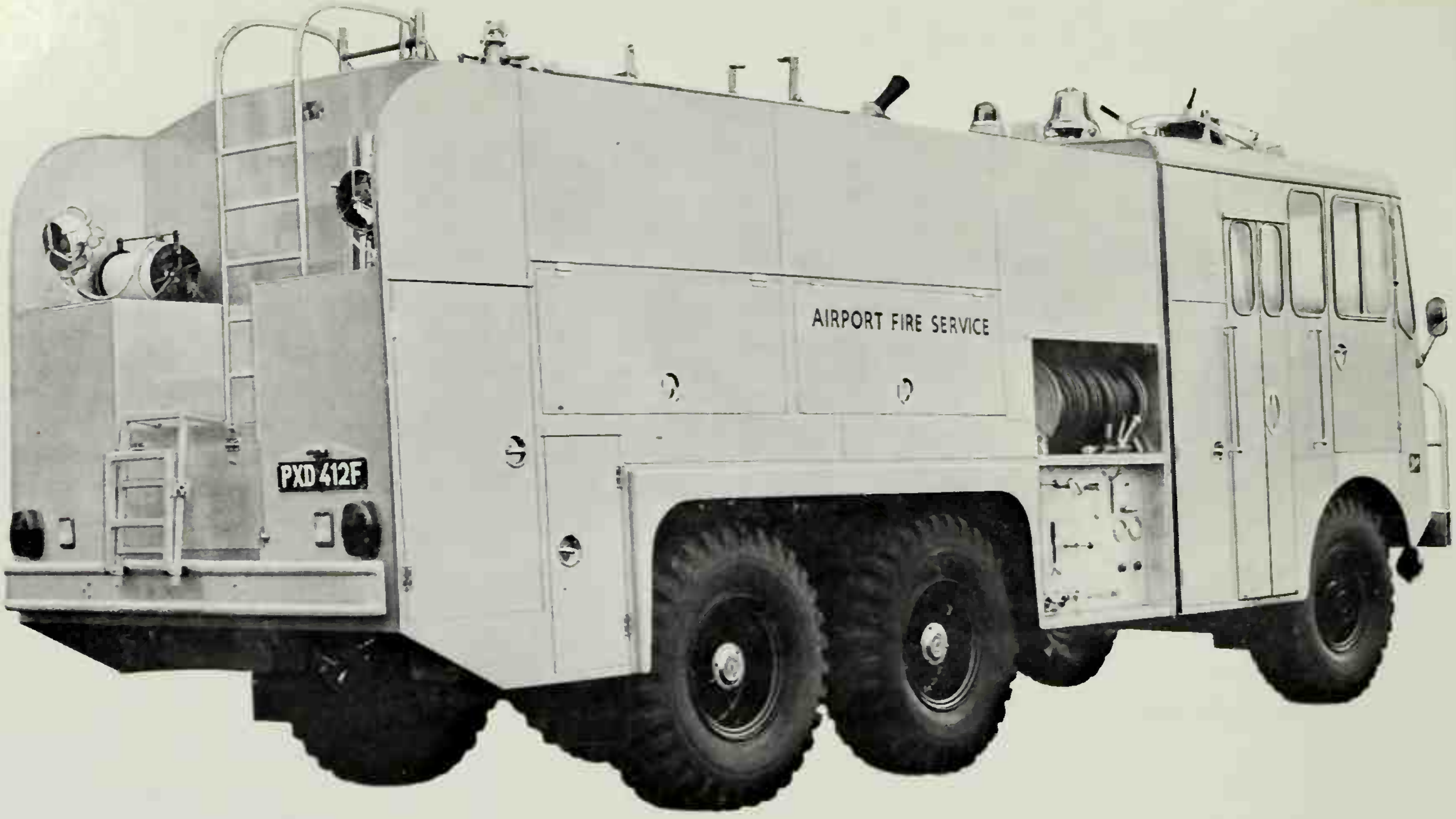
Fire extinguishers

An extensive range of Graviner fire extinguishers is available to cover all known applications. These extend from simple hand-operated types to those designed for either semi- or fully automatic systems. Automatic extinguishers can be supplied in a comprehensive range of either copper or steel containers and with either single or dual operating heads, the latter permitting a reserve 'two-shot' capability.

Of the many extinguishing agents available, bromochlorodifluoromethane (BCF) is the one most frequently recommended because of its remarkable extinguishing efficiency plus its low toxicity. It is approved by the British ARB as a replacement for methylbromide (MB), although the latter is still generally approved for use in automatic extinguishers for military aircraft. Extinguishers filled with alternative extinguishing agents, such as chlorobromomethane (CB), bromotrifluoromethane (BTM) and dibromodifluoromethane (DDM), can also be supplied to meet special risks or specific applications.

GRAVINER (COLNBROOK) LIMITED
Poyle Mill Works, Colnbrook, Slough, Buckinghamshire, England
Telephone: Colnbrook 3245 Cables: Crashfires Colnbrook Telex: 84124

GRAVINER
ONE OF THE
WILKINSON
SWORD
GROUP OF COMPANIES



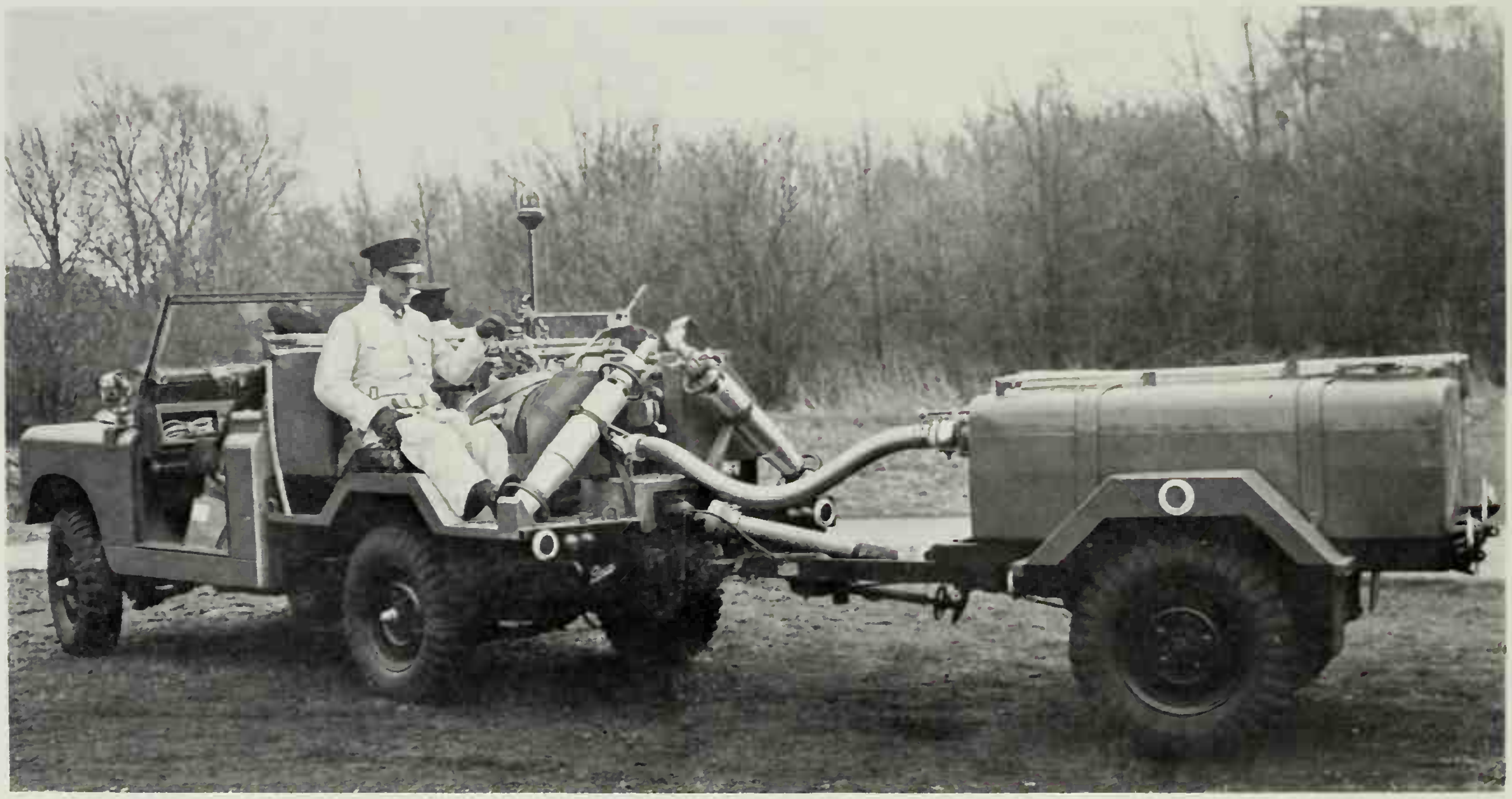
Fire-fighting vehicles

Pyrene airfield crash-fire trucks, similar to the type illustrated, are built on Thornycroft TMA/300 Nubian Major chassis and powered by Cummins V8/300 compression ignition (diesel) engines developing 300 bhp gross at 3000 rev/min.

Designed and built by the Pyrene Company, these vehicles have a foam output of 32 000–36 000 litres/min (7–8000 gal/min) through a large output monitor (turret) and four 44 mm (1 $\frac{3}{4}$ in) hand lines with FB10X branchpipes supplied from a foam compound tank of 909 litres (200 gal) capacity and a 6360 litre (1400 gal) water tank pumped through an automatically compensating aspirated foam system.

These crash trucks can be supplied with a variety of ancillary equipment and are designed to take on additional supplies of water and foam compound without breaking the continuity of foam production, the discharge rate being sustained as long as these supplies can be maintained. Foam can also be generated while the vehicles are on the move.

Pyrene manufactures a range of fire fighting vehicles on a variety of chassis, suitable for all fire fighting media.



Fire crash foam truck and trailer

This compact fire-fighting unit consists of a truck mounted on a Land Rover 277 cm (109 in) wheelbase 4 × 4 chassis and a Scottorn Bushmaster driven-axle trailer (both of which are described in detail elsewhere in this Catalogue). The unit therefore has effectively six-wheel traction and outstanding traction over difficult terrain.

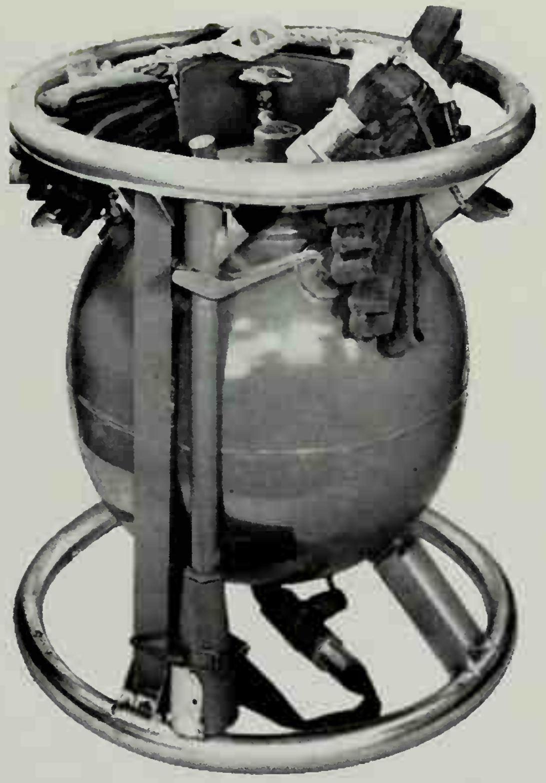
The output is up to 11 365 litres/min (2500 gal/min) of foam through two Pyrene 8/16 foam branchpipes, induced by a variable round-the-pump inductor.

The single divided tank holds 227 litres (50 gal) water and 145 litres (32 gal) foam liquid. The trailer tank contains an additional 832 litres (183 gal) water.

The unit carries a crew of three and includes provision for general and ancillary equipment.

Fire-fighting vehicles

and fire-fighting equipment



Fire-chopper units
These compact units can be conveyed to the scene of an outbreak of fire either by helicopter or by a small Land Rover-type of vehicle. The unit, charged with either 90 kg or 136 kg (200 lb or 300 lb) of dry powder, discharging through a 23 m (75 ft) length of hose, has primarily been designed to operate at crash fires that may take place outside the limits of an airfield where very rough terrain may be inaccessible to other methods of transport.

For transportation by air, the two white nylon slings (seen lying across the hose) are hooked on to a cable which is winched from the helicopter. The unit can then be turned over on to its side and the two 'wheels' enable it to be rolled along the ground.

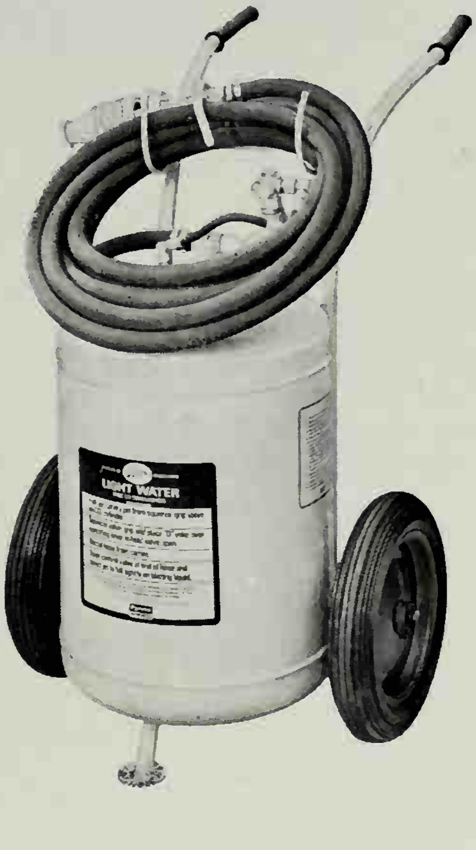
BCF hand fire extinguisher
This powerful 1·4 kg (3 lb) BCF fire extinguisher was developed by Pyrene for the British Army to MVEE Specification 1285 (NATO stock No: 4210-99-881-4724.) BCF is non-damaging, non-conductive, completely effective on all types of fire, serviceable from –45° to +75°C. The extinguisher itself is completely sealed and expendable.

Pyrene also designed and produced the fixed installations for engine compartment protection in British fighting vehicles.

SF20 trolley
This is a mobile fire extinguisher unit designed to cope with fires resulting from fuel spillage, especially on airfield aprons. It has an output of 73 litres/min (16 gal/min). The entire contents can be discharged in 74 seconds at a pressure of 10·5 kgf/cm^2 (150 lbf/in^2), giving a jet length of 12 m (40 ft).

The unit has a capacity of 91 litres (20 gal) solution at 6 percent concentration of 'light water' or Pyrene Plus F fluoroprotein foam.

The unit runs on 400-mm (16-inch) rubber-tyred wheels. The stub axles and transporting handles are welded to the container shell to save the weight of a separate chassis.

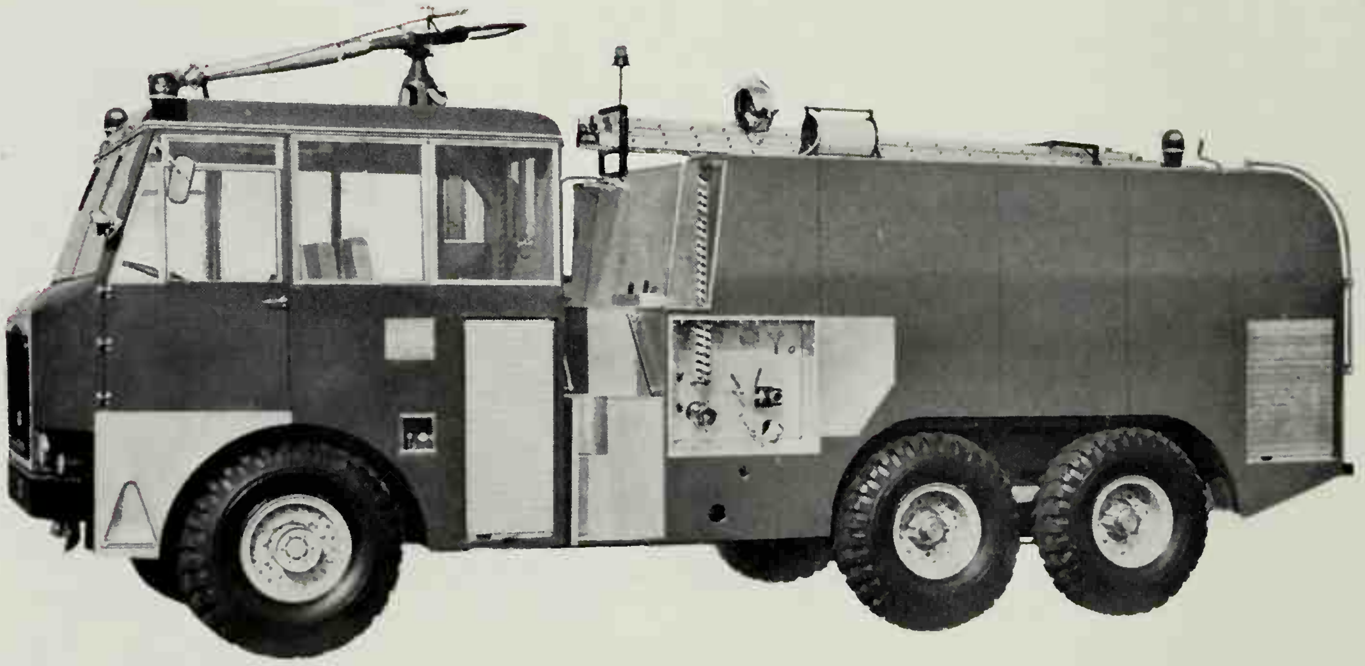


THE PYRENE COMPANY LIMITED
Pyrene House, Sunbury-on-Thames, Middlesex, England
Telephone: Sunbury-on-Thames 85588 Telex: 261402

Pyrene

Fire protection

Vehicles, installations, equipment



Emergency vehicles

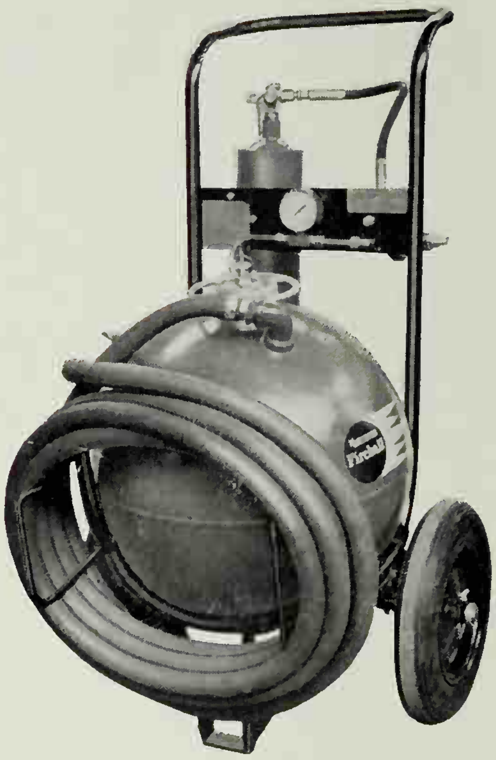
We design and build emergency fire fighting vehicles of all kinds for military and civil use. These appliances are designed to carry media appropriate to the risks involved—generally water, foam and either carbon dioxide or dry powder. The machine illustrated is based on the Thornycroft Nubian Major chassis with two driven rear axles and power-assisted steering. In the crew cab are pneumatically operated remote controls for all main valves governing water and the special Merryweather Selectamatic foam system.

Fire protection installations

Merryweather supplies specialist equipment for the protection of buildings and plant of all kinds. In addition they plan complete fire protection services and carry out all installation work. Such installations include fire alarms, sprinklers and water spray, carbon dioxide and dry powder systems for the protection of special risks such as radio stations, generating plant, laboratories, computer rooms, etc.

Fire-fighting equipment

Merryweather manufactures a very wide range of portable equipment, including hand and mobile fire extinguishers, to cover all classes of risk. The company also makes fixed and swinging nose reels, and all brigade equipment including hose, branch pipes and special nozzles.



At right: a Merryweather 'Fireball' mobile extinguisher carrying 150 lb of dry powder

A member of the Tecalemit Group of Companies
MERRYWEATHER & SONS LIMITED
Greenwich High Road, London SE10, England
Telephone: 01-692 1016 Cables: Merywether London SE10

By Appointment
to Her Majesty the Queen
Fire Engineers

MERRYWEATHER
AND SONS LIMITED

Nubian Major

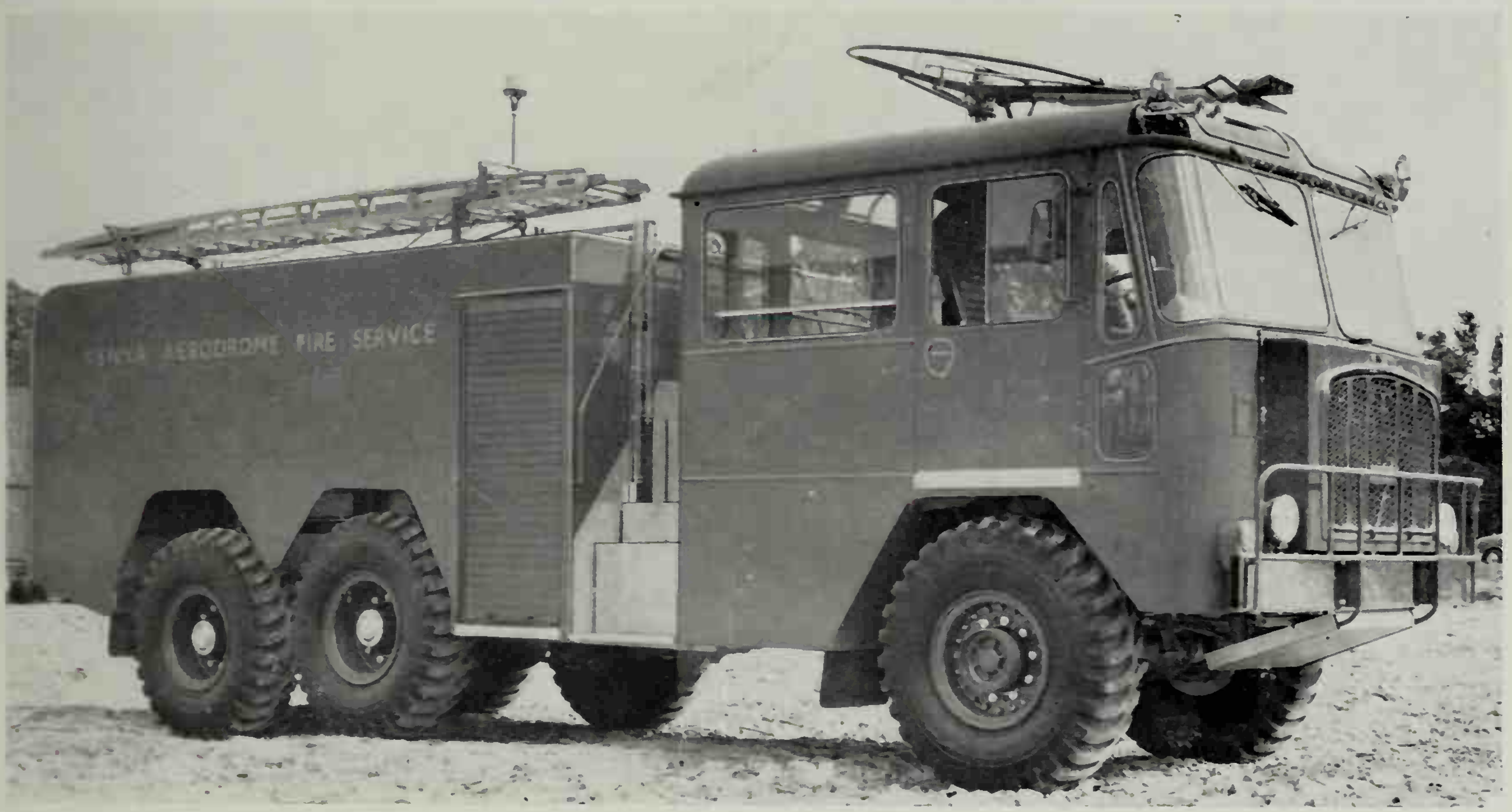
airfield fire crash tender

The Thornycroft Nubian Major 6 × 6 chassis has been designed and developed entirely as an aircraft fire crash tender. It is not a commercial vehicle variant. Consequently, the ability to meet the most basic and important requirements of an aircraft fire crash tender have been catered for at the design stage, without subsequent compromise or modification.

Experience gained over 20 years of aircraft fire crash tender manufacture has been used to produce a chassis with outstanding cross-country performance, high speeds and rapid acceleration. Well-tried and highly developed components are used to ensure reliability and readily available spare parts.

The Cummins V8 diesel engine produces 300 bhp at 3000 rev/min, giving a power-to-weight ratio of 15 bhp per ton. A 457 mm (18 in) fluid clutch and five-speed epicyclic gearbox allow gear changes to be made under full power, with no loss of speed or traction. The maximum speed of 100 km/h (62 mph) can thus be used to full advantage.

The power take-off is designed so that it can be engaged both while the vehicle is in motion and when stationary, the vehicle can therefore move around an incident and maintain a continuous foam discharge.



Specification

Engine
Cummins V8-300 diesel. A naturally aspirated eight-cylinder engine, producing 300 bhp gross, at a governed speed of 3000 rev/min. The two banks of four cylinders are in a 90 degree 'vee' configuration, with a bore and stroke of 139·7 × 104·8 mm (5½ × 4½ in) giving a cubic capacity of 12·86 litres (785 in^3).

Clutch
A 457 mm (18 in) dia fluid clutch is fitted. This is a combination of an hydraulic coupling and a centrifugal friction clutch, and uses features of both. The fluid coupling provides a perfectly smooth take-up from rest, while at higher speeds the centrifugal clutch provides a positive drive with no loss of power.

Main gearbox
The semi-automatic main gearbox is mounted as an integral unit with the engine and provides five forward speeds and one reverse. An air-operated control is used to select the gears, an indicator is provided to show which gear is in use and a built-in inhibitor unit protects the engine from damage through over-revving during downward changes.

Gear changes are made under full power (hot shift) with no loss of speed and consequent risk of bogging down in soft ground.
Ratios: 1st 7·25:1, 2nd 4·28:1, 3rd 2·43:1, 4th 1·59:1, 5th 1:1
Reverse 5·97:1

Transfer gearbox
The transfer gearbox is a two-speed spur gear unit of constant-mesh type with sliding dog change. Engagement of front-wheel drive is independent of normal gear selection and may be used with either ratio. Gear or power-drive selection is not affected by wind-up in the lower shaft.

Gear changes in the transfer box can only be carried out when stationary. High gear is suitable for all cross-country operation. Low gear is only required in emergency conditions of an exceptional nature.
Ratios are 1:1 and 1·62:1

Brakes
Split-system air-operated spring brakes are fitted as standard, providing both service and secondary systems.

The foot operates the brakes on all wheels. The secondary or parking brake control lever, which is mounted on the steering column, actuates the spring brake chambers on the rear bogie only and is capable of holding the vehicle fully laden at 21 tons on a 1 in 4 gradient.

Compressed air for braking is supplied by an engine-mounted and engine-driven compressor with a nominal output of 0·340 m^3/min (12 ft^3/min).

Electrical system
Power is provided by a 24 V negative earth 178 mm (7 in) dia alternator of 1440 W output. The batteries have a capacity of 165 Ah. The output from the alternator, even at low speeds, is sufficient to supply all lighting, radio and ancillary equipment.

Power take-off (optional)
The power take-off is usually mounted on the top of the main gearbox and is driven by the gearbox input shaft. Engagement is by a lever in the cab working through a synchromesh unit. The power take-off may be engaged while the vehicle is stationary or in motion and is capable of transmitting 150 bhp at 3000 rev/min continuously.

Wheels and tyres
Two-piece divided disc wheels with 14·00 × 20 in 20-ply cross-country tyres are standard. 15·00 × 20 in 20-ply tyres can be supplied as alternative equipment if required.

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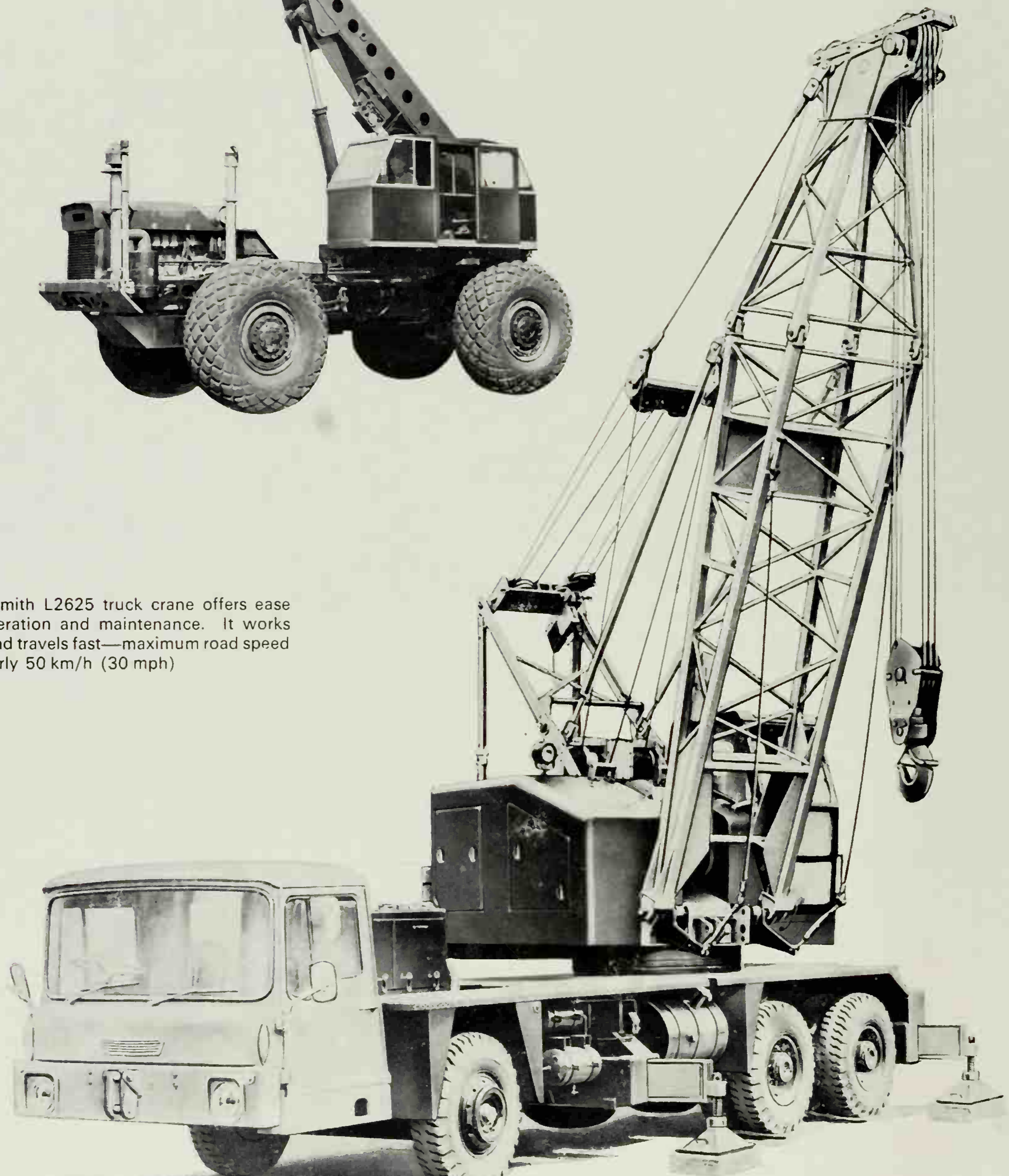
Section 32

Materials handling equipment

Smith's 10-ton rough-terrain crane, designed specially for use by the British Army, can operate in climatic conditions from –32°C to +52°C, and at altitudes up to 5000 ft, without modification



The Smith L2625 truck crane offers ease of operation and maintenance. It works fast and travels fast—maximum road speed is nearly 50 km/h (30 mph)

Heavy-duty cranes

for military and industrial uses

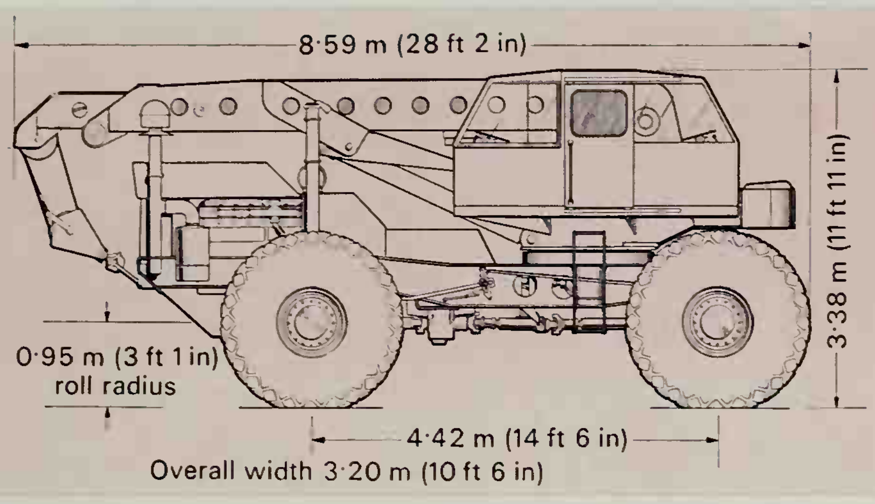
Smith's 10-ton rough-terrain crane
Specially developed to meet the rigorous requirements of the British Army, this crane offers strength and reliability in the most severe conditions. It is principally designed for general field service such as bridging and stores handling. As the crane is waterproofed for wading in sea water up to 1·85 m (6 ft 6 in) deep, with a 0·625 m (2 ft 6 in) wave and spray allowance, it can also be used as a beach crane in ship-to-shore operations.

It converts swiftly and compactly for fast convenient road travel.

Specification

Upper machinery
Power: transmitted up the centre unit to drive 4 hydraulic pumps one for each motion
Max hoist speed: 30 m/min (100 ft/min) on 3 falls, 23 m/min (75 ft/min) on 4 falls
Slewing speed: 4 rev/min
Telescopic jib, luffing speed: full range in 24 sec under load
Max gradient: 1 in 2¼
Safe working loads:
  10 tons at 3·35 m (11 ft 3 in) radius on 4 falls of rope
  7 tons at 4·27 m (14 ft) radius on 3 falls of rope
  4 tons at 5·80 m (19 ft 3 in) radius on 3 falls of rope
  1½ tons at 9·46 m (31 ft 3 in) radius on 3 falls of rope

Crane carrier
Engine: Rolls-Royce C8 NFL, 250 bhp at 2100 rev/min
Gearbox: Clark 'Power-Shift' type R-600-FS
Overall dimensions in road travel condition: Width 3·060 m (10 ft 6 in), height 3·400 m (11 ft 11 in), length 8·540 m (28 ft 2 in), wheel base 4·280 m (14 ft 6 in)
Max road speed: 56 km/h (35 mph)



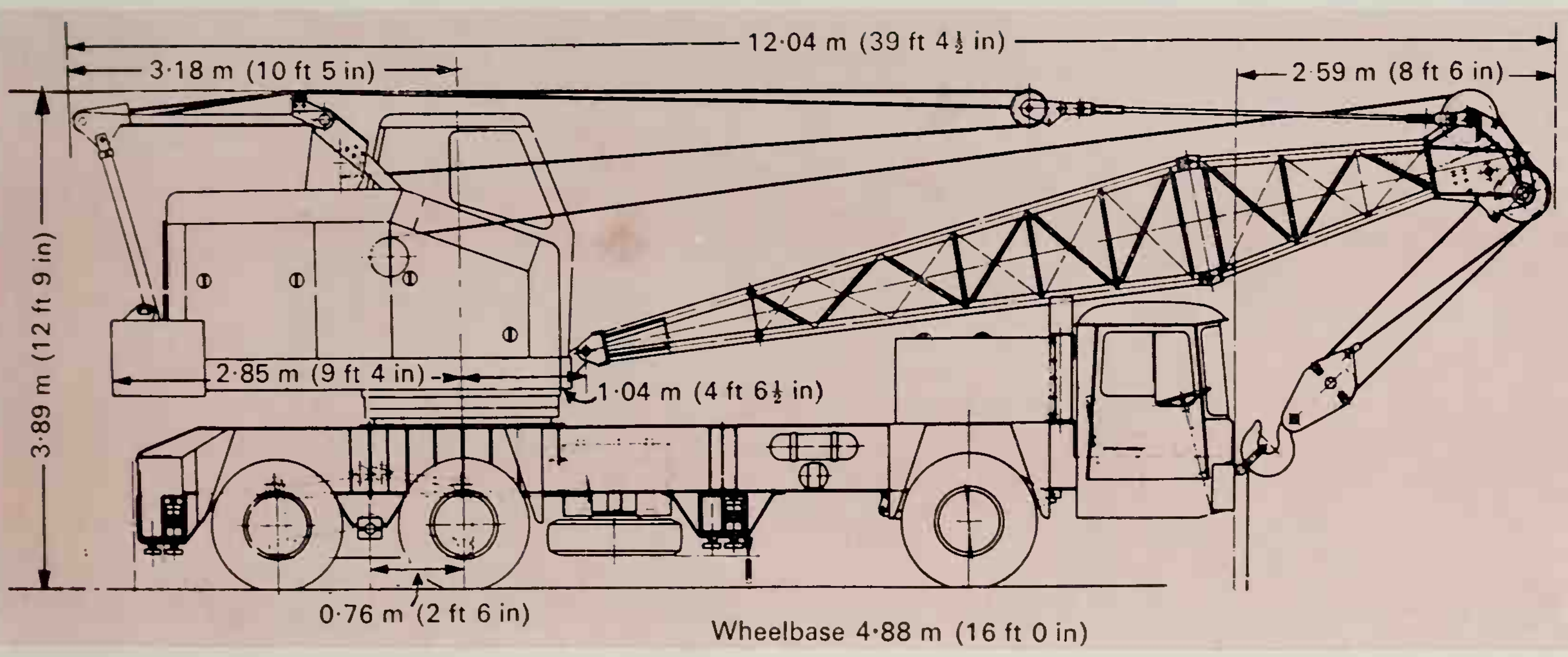
Smith's L2625 truck crane
Another crane from the famous Smith range, which is currently doing arduous duty for the British armed forces. Like all Smith's cranes and excavators, it combines ruggedness and dependability with precise, accurate lifting control.

The crane is fully slewing and has a basic boom length of 7·6 m (25 ft), extending to a maximum of 38 m (125 ft). Maximum load on a single rope is 4·3 tons. Maximum lifting capacity is 25 tons.

Specification

Upper machinery
Power unit: Perkins 6/354 6-cylinder diesel engine
Transmission: via gearbox and 'Triplex' roller chain totally enclosed, running in oil
Cab: 260° all-round vision

Crane carrier
Engine: AEC model AV691 6-cylinder diesel engine of 11·3 litres (690 in³) capacity, delivering 192 bhp at 200 rev/min
Gearbox: AEC five-speed constant-mesh type with built-in two-speed auxiliary unit
Truck frame: heavily reinforced welded steel construction
Weight of crane: 29·5 tons approx fully rigged with 7·62 m (25 ft) basic boom
Max road speed: 48 km/h (30 mph)



THOMAS SMITH & SONS (RODLEY) LIMITED
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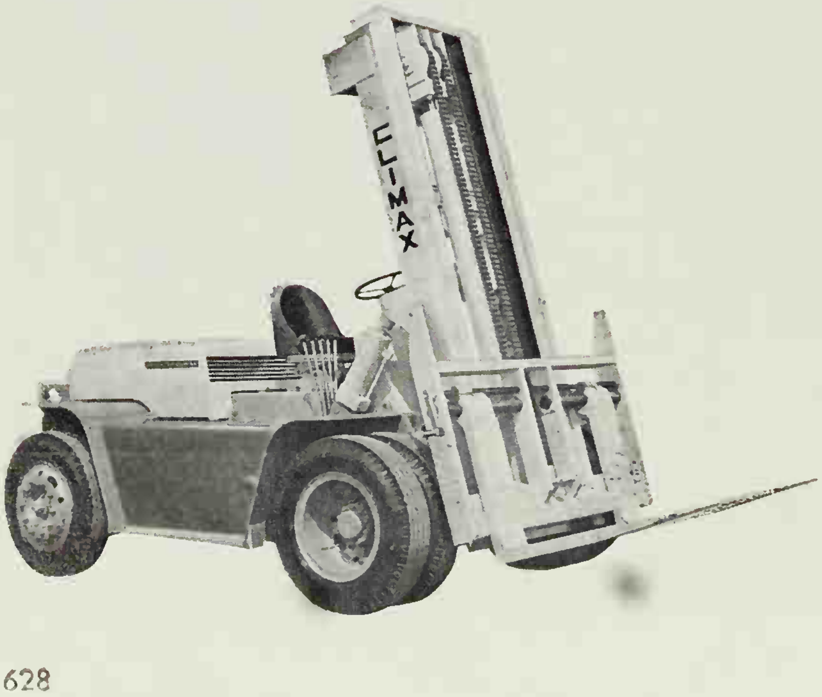
UNIVERSAL
COVENTRY CLIMAX

The Climax 50-DA diesel-powered fork lift truck shown above is one of a large fleet supplied to the British Ministry of Defence for many and varied duties, handling a variety of commodities. Optional equipment fitted to this truck are overhead guard and canopy, carriage back-rest extension, lighting equipment and rear view mirrors

It is important to note that the Climax range includes electric, diesel, petrol and liquefied petroleum-gas-powered models, the correct power unit therefore being available for any particular application to give maximum efficiency and operating economy.

Many variations of the basic specification are available. For example, Climax mechanical trucks are produced in alternative versions having pneumatic or cushion tyres; the pneumatic tyres are called for when working surfaces are uneven, loose or wet, but if working on good dry surfaces cushion tyres (with their lower rate of wear) are ideal.

In the table for petrol and LP gas trucks on the right, please note that trucks with the suffixes PC and PA are petrol-powered, GC and GA are LP gas-powered.



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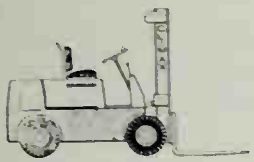
CLIMAX

The largest and the smallest in the Climax mechanical truck range. Above is a 20-PA of 907 kg capacity and to the left is one of the larger trucks which have capacities up to 8165 kg

Mechanical fork lift trucks

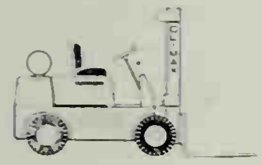
for use on land and on board ship

Diesel



Model	Capacity at 610 mm (24 in) centres	Type of tyres	Trans-mission ††	Standard lift height*	Min aisle width for 90° stacking†	Turning radius	Overall length less forks	Overall width	Lift speed (laden)	Travel speed (laden)‡
20-DC	907 kg 2000 lb	Cushion	D	3302 mm 130 in	3277 mm 129 in	1676 mm 66 in	2076 mm 75¾ in	991 mm 39 in	21·3 m/min 70 ft/min	14·5 km/h 9 mph
20-DA	907 kg 2000 lb	Pneumatic	D	3302 mm 130 in	3277 mm 129 in	1676 mm 66 in	2076 mm 75¾ in	991 mm 39 in	21·3 m/min 70 ft/min	17 km/h 10·5 mph
IGDF	1361 kg 3000 lb	Cushion	D	3302 mm 130 in	3404 mm 134 in	1841 mm 72½ in	2134 mm 80½ in	965 mm 38 in	18·3 m/min 60 ft/min	12·9 km/h 8 mph
IGDFA	1361 kg 3000 lb	Pneumatic	D	3302 mm 130 in	3505 mm 138 in	1867 mm 73½ in	2102 mm 82¾ in	1067 mm 42 in	18·3 m/min 60 ft/min	16·1 km/h 10 mph
IGD	1814 kg 4000 lb	Cushion	D	3302 mm 130 in	3505 mm 138 in	1943 mm 76½ in	2134 mm 84 in	965 mm 38 in	16·8 m/min 55 ft/min	12·9 km/h 8 mph
40-DA	1814 kg 4000 lb	Pneumatic	D, O or Q	3302 mm 130 in	3804 mm 149¾ in	2134 mm 84 in	2375 mm 93½ in	1099 mm 43¼ in	29 m/min 95 ft/min	19·2 km/h 12 mph
50-DA	2268 kg 5000 lb	Pneumatic	D, O or Q	3302 mm 130 in	3854 mm 151¾ in	2184 mm 86 in	2419 mm 95¼ in	1187 mm 46¾ in	27·4 m/min 90 ft/min	19·2 km/h 12 mph
60-DC	2722 kg 6000 lb	Cushion	O	3302 mm 130 in	3810 mm 150 in	2159 mm 85 in	2438 mm 96 in	1079 mm 42½ in	18·3 m/min 60 ft/min	14·5 km/h 9·5 mph
60-DA	2722 kg 6000 lb	Pneumatic	O or Q	3302 mm 130 in	4096 mm 161¼ in	2311 mm 91 in	2756 mm 108½ in	1270 mm 50 in	21·4 m/min 70 ft/min	19·4 km/h 12·1 mph
70-DC	3175 kg 7000 lb	Cushion	O	2997 mm 118 in	3861 mm 152 in	2210 mm 87 in	2502 mm 98½ in	1168 mm 46 in	18·3 m/min 60 ft/min	14·5 km/h 9·5 mph
70-DA/S	3175 kg 7000 lb	Pneumatic (single (front)	O or Q	2997 mm 118 in	4121 mm 162¼ in	2337 mm 92 in	2781 mm 109½ in	1270 mm 50 in	19·8 m/min 65 ft/min	19·4 km/h 12·1 mph
70-DA/T	3175 kg 7000 lb	Pneumatic (twin front)	O or Q	2997 mm 118 in	4401 mm 173¼ in	2616 mm 103 in	2908 mm 114½ in	1676 mm 66 in	19·8 m/min 65 ft/min	18·8 km/h 11·75 mph
80-DC	3629 kg 8000 lb	Cushion	O	2997 mm 118 in	4013 mm 158 in	2349 mm 92½ in	2654 mm 104½ in	1168 mm 46 in	18·3 m/min 60 ft/min	14·5 km/h 9·5 mph
80-DA	3629 kg 8000 lb	Pneumatic	O or Q	2997 mm 118 in	4426 mm 174¼ in	2642 mm 104 in	2934 mm 115½ in	1676 mm 66 in	18·3 m/min 60 ft/min	18·8 km/h 11·75 mph
100-DA	4536 kg 10 000 lb	Pneumatic	Q	3658 mm 144 in	4826 mm 190 in	3048 mm 120 in	3245 mm 127¾ in	1803 mm 71 in	21·4 m/min 70 ft/min	35·2 km/h 22 mph
120-DA	5443 kg 12 000 lb	Pneumatic	Q	3658 mm 144 in	4928 mm 194 in	3124 mm 123 in	3327 mm 131 in	1803 mm 71 in	21·4 m/min 70 ft/min	35·2 km/h 22 mph
150-DA	6804 kg 15 000 lb	Pneumatic	Q	3658 mm 144 in	5817 mm 229 in	3912 mm 154 in	4083 mm 160¾ in	2286 mm 90 in	23·2 m/min 76 ft/min	32 km/h 20 mph
180-DA	8165 kg 18 000 lb	Pneumatic	Q	3658 mm 144 in	5842 mm 230 in	3924 mm 154½ in	4108 mm 161¾ in	2388 mm 94 in	23·2 m/min 76 ft/min	37·7 km/h 23·4 mph

Petrol and LP gas



Model	Capacity at 610 mm (24 in) centres	Type of tyres	Trans-mission ††	Standard lift height*	Min aisle width for 90° stacking†	Turning radius	Overall length less forks	Overall width	Lift speed (laden)	Travel speed (laden)‡
20-PC 20-GC	907 kg 2000 lb	Cushion	D	3302 mm 130 in	3277 mm 129 in	1676 mm 66 in	2076 mm 75¾ in	991 mm 39 in	21·3 m/min 70 ft/min	14·5 km/h 9 mph
20-PA 20-GA	907 kg 2000 lb	Pneumatic	D	3302 mm 130 in	3277 mm 129 in	1676 mm 66 in	2076 mm 75¾ in	991 mm 39 in	21·3 m/min 70 ft/min	17 km/h 10·5 mph
IGPF IGPF(LPG)	1361 kg 3000 lb	Cushion	D or Q	3802 mm 130 in	3404 mm 134 in	1841 mm 72½ in	2134 mm 80½ in	965 mm 38 in	18·3 m/min 60 ft/min	12·9 km/h 8 mph
IGPFA IGPFA (LPG)	1361 kg 3000 lb	Pneumatic	D or Q	3302 mm 130 in	3505 mm 138 in	1867 mm 73½ in	2102 mm 82¾ in	1067 mm 42 in	18·3 m/min 60 ft/min	16·1 km/h 10 mph
IGP IGP(LPG)	1814 kg 4000 lb	Cushion	D or Q	3302 mm 130 in	3505 mm 138 in	1943 mm 76½ in	2134 mm 84 in	965 mm 38 in	16·8 m/min 55 ft/min	12·9 km/h 8 mph
IGPA IGPA (LPG)	1814 kg 4000 lb	Pneumatic	D or Q	3302 mm 130 in	3785 mm 149 in	2096 mm 82½ in	2362 mm 93 in	1067 mm 42 in	16·8 m/min 55 ft/min	19·3 km/h 12 mph
60-PA 60-GA	2722 kg 6000 lb	Pneumatic	O or Q	3302 mm 130 in	4096 mm 161¼ in	2311 mm 91 in	2756 mm 108½ in	1270 mm 50 in	21·4 m/min 70 ft/min	19·4 km/h 12·1 mph
70-PA/S 70-GA/S	3175 kg 7000 lb	Pneumatic (single front)	O or Q	2997 mm 118 in	4121 mm 162¼ in	2337 mm 92 in	2781 mm 109½ in	1270 mm 50 in	19·8 m/min 65 ft/min	19·4 km/h 12·1 mph
70-PA/T 70-GA/T	3175 kg 7000 lb	Pneumatic (twin front)	O or Q	2997 mm 118 in	4401 mm 173¼ in	2616 mm 103 in	2908 mm 114½ in	1676 mm 66 in	19·8 m/min 65 ft/min	18·8 km/h 11·75 mph
80-PA 80-GA	3629 kg 8000 lb	Pneumatic	O or Q	2997 mm 118 in	4426 mm 174¼ in	2642 mm 104 in	2934 mm 115½ in	1676 mm 66 in	18·3 m/min 60 ft/min	18·8 km/h 11·75 mph
100-PA 100-GA	4536 kg 10 000 lb	Pneumatic	Q	3658 mm 144 in	4826 mm 190 in	3048 mm 120 in	3245 mm 127¾ in	1803 mm 71 in	21·4 m/min 70 ft/min	35·2 km/h 22 mph
120-PA 120-GA	5443 kg 12 000 lb	Pneumatic	Q	3658 mm 144 in	4928 mm 194 in	3124 mm 123 in	3327 mm 131 in	1803 mm 71 in	21·4 m/min 70 ft/min	35·2 km/h 22 mph

* Alternative lift heights available on request
† With 1219 mm (48 in) cube load

‡ With clutch and manual gearbox; speeds with torque converter approx. 5% lower

†† D = Dry clutch and manual gearbox
O = Oil-cooled clutch and manual gearbox
Q = Torque converter

COVENTRY CLIMAX ENGINES LIMITED
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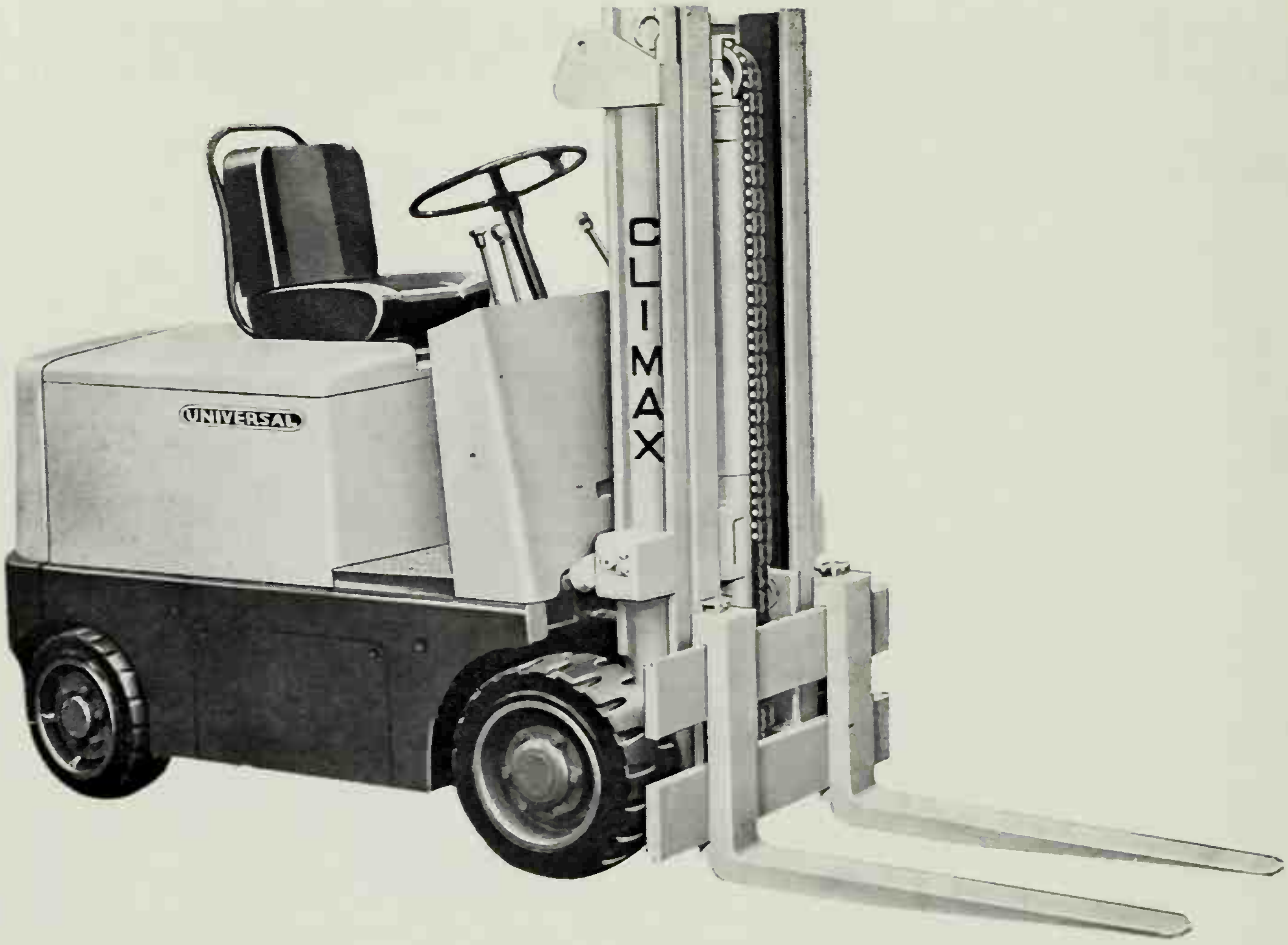


The Climax 50-EC electric fork lift truck shown above is fitted with the new Climax SCR '72 electronic control system, and is one of the most widely used fork trucks in the range

Fitted with standard forks, the trucks are versatile 'maids of all work', able to lift, transport and stack most types of material which, in a highly organised storage and handling system, are usually borne on pallets or stillages for ease of movement and optimum use of available storage space. Alternatively, the trucks can be fitted with a wide variety of attachments for carrying out specialised tasks, or for handling goods which cannot easily be palletised. Examples of such attachments range from a simple rigid crane interchangeable with the standard forks to sophisticated devices such as semi-automatic ladles for molten metal, or hydraulically operated retractable overhead cranes.

The availability of electric, diesel, petrol or LPG power is of great importance, correct choice of power unit being vital for maximum efficiency and operating economy. Briefly, it can be said that battery-electric trucks are particularly suited to indoor work, on good surfaces or on short runs; diesel trucks are suited to outdoor work or longer runs.

Features of the Climax range include: good accessibility for ease of servicing, interchangeability of component parts between the various models, long wheelbase for lower tyre wear and light steering, and built to recognised international standards (FEM, ITA, BITA).

As will be seen from the tables opposite, most Climax electric trucks are fitted with the new Climax SCR '72 electronic control system, giving smooth stepless acceleration, great economy and reliability, easy maintenance, and faster lift and travel speeds. A heavy-duty traction motor drives the truck through bevel and spur gearing. A plug-and-socket arrangement facilitates recharging. Alternatively, the battery may be quickly removed and replaced by a charged spare battery.

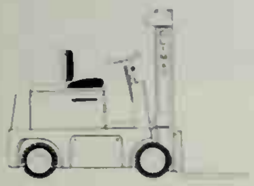
Climax fork lift trucks are in widespread use by government departments, nationalised industries and port authorities throughout the world, in regular supply to the British armed services since 1946 and in service with the armed forces of Canada and Denmark.

Electric fork lift trucks

for use on land and on board ship

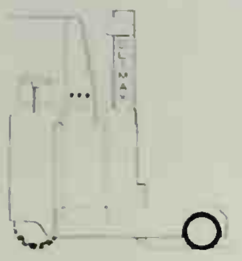
In 1946 Coventry Climax Engines Ltd pioneered fork lift trucks in Britain, and since then the company's range has been extended to include over 50 different models, covering battery-electric, diesel, petrol and liquefied-petroleum-gas-powered versions with capacities from 900–8165 kg (2000–18 000 lb) at 610 mm (24 in) load centres, each model being available with a wide variety of optional equipment.

On these two pages, details are given of the electric range, including reach trucks and tractors. On the following two pages, mechanically powered models are detailed.



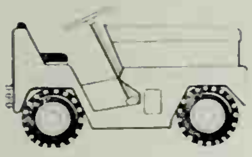
Electric fork trucks

Model	Capacity at 610 mm (24 in) centres	Type of tyres	Control system	Standard lift height*	Minimum aisle-width for 90° stacking†	Turning radius	Overall length less forks	Overall width	Lift speed (laden)	Travel speed (laden)
IGEU20	907 kg‡ 2000 lb‡	Cushion	Contactors 36 V	3302 mm 130 in	2762 mm 108¾ in**	1448 mm 57 in	1600 mm 63 in	838 mm 33 in	9·8 m/min 32 ft/min	7·6 km/h 4·75 mph
IGEU24	907 kg 2000 lb	Cushion	Contactors 36 V	3302 mm 130 in	2965 mm 116¾ in	1486 mm 58½ in	1638 mm 64½ in	838 mm 33 in	9·8 m/min 32 ft/min	7·6 km/h 4·75 mph
20-EC	907 kg 2000 lb	Cushion	SCR 36 V	3302 mm 130 in	2997 mm 118 in	1473 mm 58 in	1588 mm 62½ in	838 mm 33 in	13·4 m/min 44 ft/min	9·7 km/h 6 mph
IGETA	907 kg 2000 lb	Pneumatic	DVD 36 V	3302 mm 130 in	3175 mm 125 in	1575 mm 62 in	1740 mm 68½ in	965 mm 38 in	13·4 m/min 44 ft/min	10·5 km/h 6·5 mph
25-EC	1134 kg 2500 lb	Cushion	SCR 36 V	3302 mm 130 in	3023 mm 119 in	1473 mm 58 in	1638 mm 64½ in	838 mm 33 in	12·8 m/min 42 ft/min	8·8 km/h 5·5 mph
30-EC	1361 kg 3000 lb	Cushion	SCR 72 V	3302 mm 130 in	3150 mm 124 in	1632 mm 64¼ in	1797 mm 70¾ in	991 mm 39 in	16·8 m/min 60 ft/min	11·3 km/h 7 mph
IGEFA	1361 kg 3000 lb	Pneumatic	DVD 36 V	3302 mm 130 in	3353 mm 132 in	1753 mm 69 in	1994 mm 78½ in	1067 mm 42 in	10·7 m/min 35 ft/min	10·5 km/h 6·5 mph
40-EC	1814 kg 4000 lb	Cushion	SCR 72 V	3302 mm 130 in	3391 mm 133½ in	1816 mm 71½ in	1968 mm 77½ in	1067 mm 42 in	18·3 m/min 60 ft/min	11·3 km/h 7 mph
IGEA	1814 kg 4000 lb	Pneumatic	DVD 36 V	3302 mm 130 in	3571 mm 141 in	1943 mm 76½ in	2159 mm 85 in	1194 mm 47 in	12·2 m/min 40 ft/min	11·3 km/h 7 mph
50-EC	2268 kg 5000 lb	Cushion	SCR 72 V	3302 mm 130 in	3505 mm 138 in	1924 mm 75¾ in	2070 mm 81½ in	1067 mm 42 in	19·8 m/min 65 ft/min	11·3 km/h 7 mph
60-EC	2722 kg 6000 lb	Cushion	SCR 72 V	3302 mm 130 in	3670 mm 144½ in	2019 mm 79½ in	2422 mm 88½ in	1080 mm 42½ in	18·3 m/min 60 ft/min	11·3 km/h 7 mph
70-EC	3175 kg 7000 lb	Cushion	SCR 72 V	2997 mm 118 in	3708 mm 146 in	2057 mm 81 in	2286 mm 90 in	1191 mm 46⅞ in	14·6 m/min 48 ft/min	10·5 km/h 6·5 mph
80-EC	3629 kg 8000 lb	Cushion	SCR 72 V	2997 mm 118 in	3912 mm 154 in	2261 mm 89 in	2470 mm 97¼ in	1191 mm 46⅞ in	13·7 m/min 45 ft/min	10·5 km/h 6·5 mph



45-RT reach truck

Capacity at 610 mm (24 in) centres	Type of tyres	Control system	Standard lift height*	Minimum aisle width for 90° stacking†	Turning radius	Overall length less forks	Overall width	Lift speed (laden)	Travel speed (laden)
2041 kg 4500 lb	Duthane front Cushion rear	SCR 36 V	3302 mm 130 in	2533 mm 99 in	1803 mm 71 in	1896 mm 74⅝ in	1207 mm 47½ in	12·2 m/min 40 ft/min	8·4 km/h 5·25 mph



TE electric tractor

Towing capacity (15 min rating)	Towing capacity (continuous)	Type of tyres	Control system	Turning radius	Overall length (over towing coupling)	Overall width	Travel speed (unladen)
25·4 tonnes at 6·4 km/h 25 tons at 4 mph	10·2 tonnes 10 tons	Cushion or pneumatic	DVD 72 V	2007 mm 79 in	2073 mm 81⅝ in	1168 mm 46 in	20·9 km/h 13 mph

* Alternative lift heights available on request
† With 1219 mm (48 in) cube load
‡ At 508 mm (20 in) centres
** With 1016 mm (40 in) cube load

COVENTRY CLIMAX ENGINES LTD
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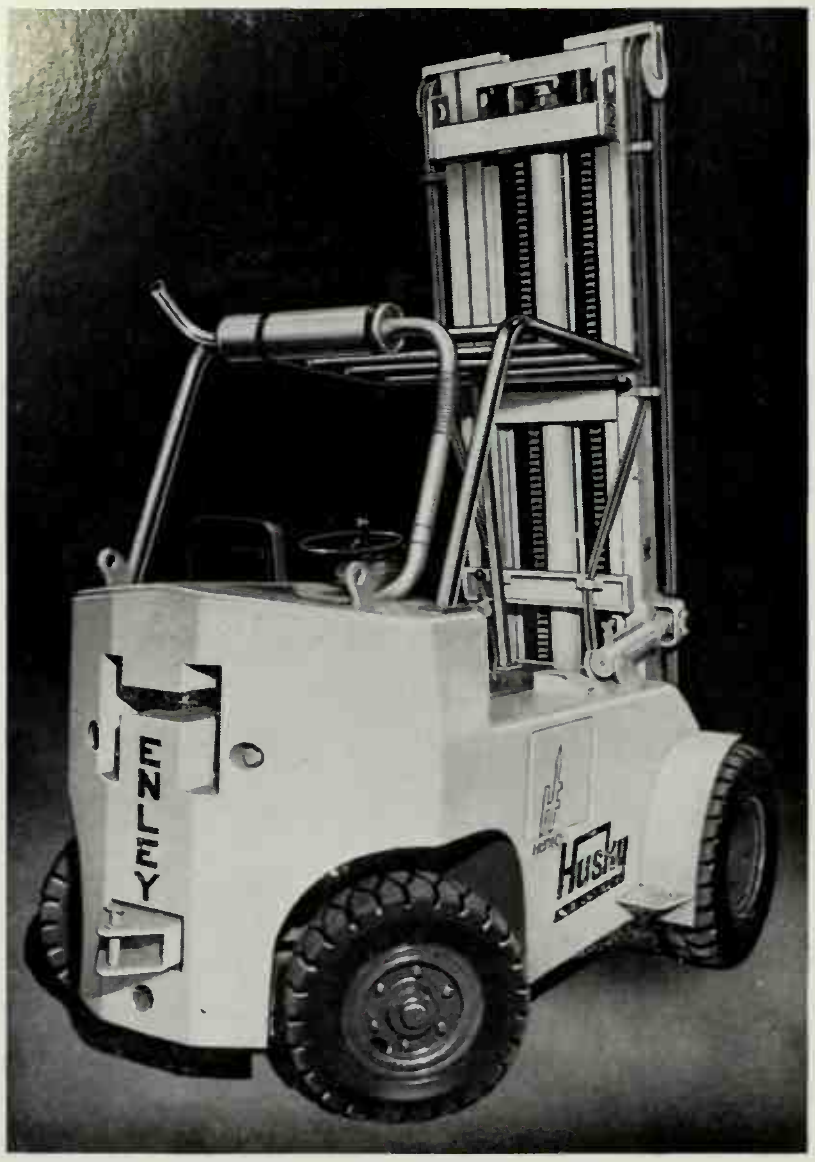

HENLEY
Husky

MANCHESTER LINERS
UK-CANADA-USA
HENLEY
Hercules

BRITISH LEYLAND
AUSTIN CARS
MORRIS CARS
HENLEY
Hawk

Henley fork lift trucks range in capacity from 1800 kg (4000 lb) to 30 tons and are popular in many parts of the world for a wide variety of military and commercial handling tasks

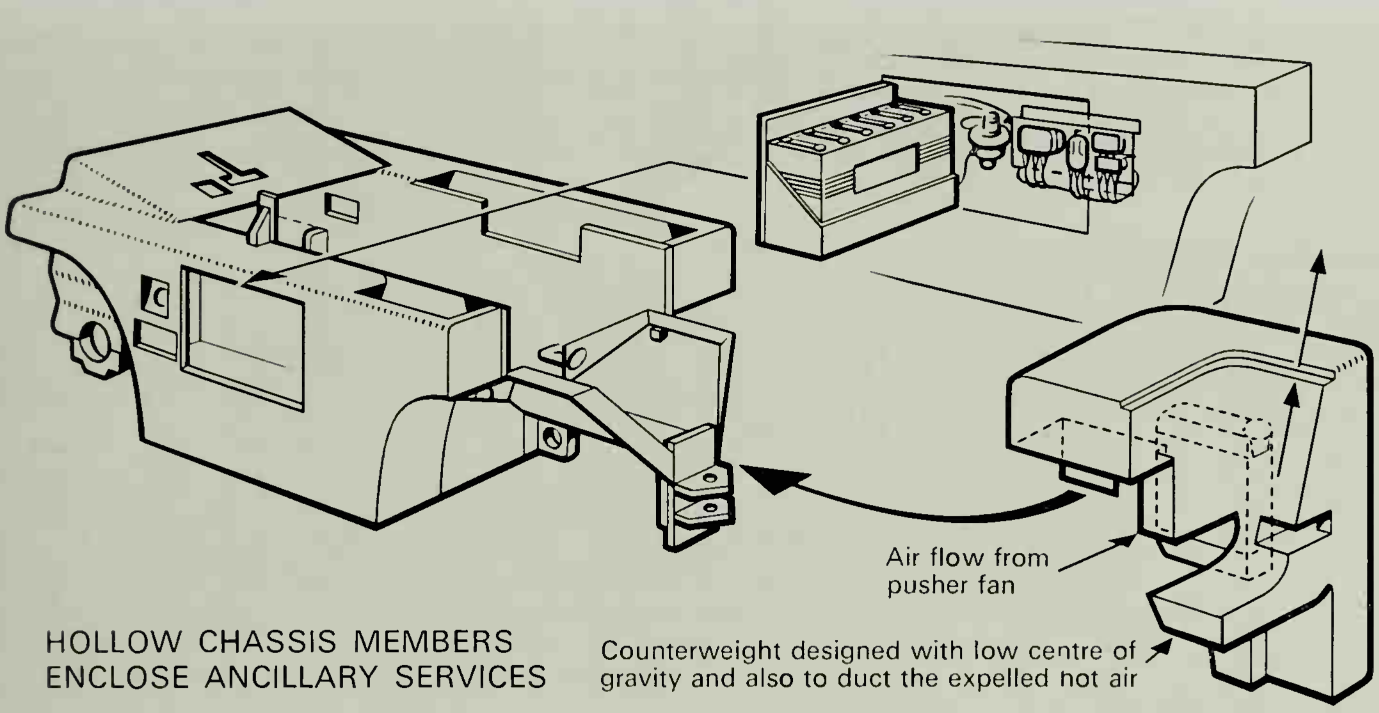
Fork lift trucks

for military and industrial use

Fork lift trucks are rated for capacity at 610 mm (24 in) from the front face of the fork and are expected to comply with British Standard 3726 which lays out four stability tests to ensure safe rated capacities.

The latest addition to the Henley range is the Hawk series, made in three sizes of 1800, 2270 and 2720 kg (4000, 5000 and 6000 lb) capacity.

The Henley Hawk chassis is fabricated from steel plate, the hollow vertical portion of the U-section being utilised as tanks for 41 litres (9 gal) fuel, 68 litres (15 gal) hydraulic oil for the main system and 4·5 litres (1 gal) for steering, and for tucking away components such as the battery. The latter is carried on a hinged panel which can be swung out revealing the battery, rectifiers and control apparatus for the alternator.


Air flow from pusher fan
Counterweight designed with low centre of gravity and also to duct the expelled hot air

HOLLOW CHASSIS MEMBERS ENCLOSE ANCILLARY SERVICES

Specification

Engine
Perkins 4·203 4-cylinder diesel engine complete with 12 V electrical starting equipment, developing 60 bhp at 2400 rev/min.

Hydraulic lift and tilt
Self-centring balanced valves under the control of the operator diverts the flow of oil produced by a vane-type hydraulic pump into the tilt or mast cylinders. A relief valve, set to 134 kgf/cm² (1900 lbf/in²), is incorporated into the system to prevent overloading. A full-flow micronic filter prevents damage to the system components

Transmission
A single-stage torque converter with a torque multiplication of 2·8:1 transmits torque to constant-mesh gears for forward and reverse travel. The transmission has a locking device to prevent the direction of travel being changed at too high speed and a creep valve for vehicle inching control. Oil from the torque converter is pumped through a finned radiator to ensure adequate cooling

Steer-axle
A heavy-duty deflector plate on Spheralastik bushes provides sufficient wheel movement for stability over uneven ground

Steering
The rear wheels are steered by the action of an hydraulic ram connected to track rods operating on stub axles which pivot on king pins. Movement of the steering wheel actuates a small hydraulic pump which controls the flow from a separate steering pump into a steer cylinder

Chassis
Monocoque box chassis of fabricated steel plate, giving tremendous strength and full protection to components. Integral fuel tanks

Load guard
Heavy steel tubing load guard fitted as standard, with twin front supports which do not restrict visibility

Radiator and oil cooler
Radiators and oil cooler are flexibly mounted on rubber bushes to prevent fractures due to excessive vibration

Controls
Two-pedal movement control in normal automotive position. All control levers are within easy reach of the driver's right hand. The full instrumentation panel ensures early fault detection. The seat position is selected to give the driver greater all-round visibility

Maintenance
The lightweight glassfibre-reinforced plastics engine cowl clips on and is easily and quickly removed. The whole engine is accessible for quick adjustment and maintenance. Check points are readily accessible. The two hydraulic pumps ensure efficient operation of all hydraulic functions at all engine speeds, resulting in finger-light steering. High-quality valves ensure precise control of hydraulic functions

HENLEY FORKLIFT COMPANY LIMITED
Newbridge Road Industrial Estate, Pontllanfraith, Blackwood,
Monmouthshire, NP2 2XF, Wales
Telephone: Blackwood 2671 Telex: 49655

Range	Model	Capacity, at load centre				Outer turning radius		Width of 90° stacking aisle (plus load length)		Diesel engine	Petrol engine	LPG engine	Electric drive	Powershifttransmission	Manual transmission	Electronic control	Standard upright	Free-lift upright	Three-stage upright	Four-stage upright
		kg	mm	lb	in	mm	in	mm	in											
Electric trucks																				
SpaceSaver (cushion-tyred)	L20B	1000	500	2000	24	1475	58	1800	71				●			●	●	●	●	
	L25B	1250	500	2500	24	1550	61	1865	73½				●			●	●	●	●	
	L30B	1500	500	3000	24	1600	63	1930	76				●			●	●	●	●	
	L35B	1750	500	3500	24	1725	68	2085	82				●			●	●	●	●	
	L40C	2000	500	4000	24	1805	71	2160	85				●			●	●	●	●	
	L50C	2500	500	5000	24	1805	71	2160	85				●			●	●	●	●	
	L60D	3000	500	6000	24	2070	81½	2465	97				●			●	●	●	●	
	L70D	3500	500	7000	24	2070	81½	2465	97				●			●	●	●	●	
	L80D	4000	500	8000	24	2260	89	2630	103½				●			●	●	●	●	
Challenger (pneumatic-tyred)	E30A	1500	500	3000	24	1755	69	2150	84⅝				●			●	●	●	●	
	E40A	2000	500	4000	24	1980	78	2420	95¼				●			●	●	●	●	
Reach truck	R25B	1200	500	2500	20	1390	54¾	1650	65				●			●	●			
	R35C	1800	500	3500	24	1570	61¾	2300	90½				●			●	●	●	●	
	R45C	2310	500	4500	24	1670	65¾	2400	94½				●			●	●	●	●	
Diesel, petrol or LP gas trucks																				
SpaceSaver (cushion-tyred)	S20A	1000	500	2000	24	1590	62½	1905	75		●	●		●	●		●	●	●	
	S25A	1250	500	2500	24	1650	65	1995	78½		●	●		●	●		●	●	●	
	S30A	1500	500	3000	24	1700	67	2050	80¾		●	●		●	●		●	●	●	
	S30C	1500	500	3000	24	1820	71¾	2140	84¼	●	●	●		●	●		●	●	●	●
	S40C	2000	500	4000	24	1885	74¼	2205	86¾	●	●	●		●	●		●	●	●	●
	S50C	2500	500	5000	24	1945	76½	2260	89	●	●	●		●	●		●	●	●	●
	S60B	3000	500	6000	24	2145	84½	2535	99⅞	●	●	●		●	●		●	●	●	
	S70B	3500	500	7000	24	2185	86	2575	101⅜	●	●	●		●	●		●	●	●	
	S80B	4000	500	8000	24	2300	90½	2690	105⅞	●	●	●		●	●		●	●	●	
	S100B	5000	500	10 000	24	2515	99	2945	116	●	●	●		●	●		●	●	●	
	S125A	5700	600	12 500	24	2495	98¼	2970	117	●	●	●		●	●		●		●	
	S150A	6850	600	15 000	24	2585	101¾	3060	120½	●	●	●		●	●		●		●	
Challenger (pneumatic-tyred)	H20E	1000	500	2000	24	1725	68	2080	82	●	●	●		●	●		●	●	●	
	H25E	1250	500	2500	24	1725	68	2080	82	●	●	●		●	●		●	●	●	
	H30E	1500	500	3000	24	1820	71¾	2205	86⅞	●	●	●		●	●		●	●	●	
	H30F	1500	500	3000	24	2120	83½	2570	101¼	●	●	●		●	●		●	●	●	
	H40F	2000	500	4000	24	2120	83½	2570	101¼	●	●	●		●	●		●	●	●	
	H50F	2500	500	5000	24	2205	86¾	2615	104½	●	●	●		●	●		●	●	●	
	H60F	3000	500	6000	24	2310	90⅞	2780	109⅜	●	●	●		●	●		●	●	●	
	H60C	3000	500	6000	24	2440	96	2980	117¼	●	●	●		●	●		●	●	●	
	H70C	3500	500	7000	24	2440	96	2980	117¼	●	●	●		●	●		●	●	●	
	H80C	4000	500	8000	24	2700	107	3260	128¼	●	●	●		●	●		●	●	●	
	H110F	5000	600	11 000	24	3215	126½	3785	149	●	●	●		●	●		●			
	H130F	5900	600	13 000	24	3265	128½	3835	151	●	●	●		●	●		●			
	H150F	6850	600	15 000	24	3355	132	3940	155	●	●	●		●	●		●			
	H150E	6850	600	15 000	24	3685	145	4335	170½	●	●	●		●	●		●			
	H165E	7500	600	16 500	24	3685	145	4335	170½	●	●	●		●	●		●			
	H180E	8250	600	18 000	24	3685	145	4335	170½	●	●	●		●	●		●			
	H200ES	9100	600	20 000	24	3720	146½	4370	172	●	●	●		●	●		●			
	H225E	10 250	600	22 500	24	4110	161¾	4790	188½	●	●	●		●	●		●			
	H250E	11 400	600	25 000	24	4165	164	4870	191¾	●	●	●		●	●		●			
	H300A	13 600	600	30 000	24	4650	183	5400	212½	●	●	●		●	●		●			
	H360B	18 000	750	36 000	36	5540	218	6555	258	●	●			●	●		●			
	H400B	19 900	750	40 000	36	5540	218	6555	258	●	●			●			●			
	H460B	20 900	1220	46 000	48	5945	234	7010	276	●	●			●			●			
	H520B	23 800	1220	52 000	48	5995	236	7040	277	●	●			●			●			
	H620B	28 100	1220	62 000	48	6580	259	7620	300	●	●			●			●			
Pioneer (rough terrain)	P60A	3000	500	6000	24	3930	154¾	4540	178¾	●	●	●			●		●		●	
	P80A	4000	500	8000	24	4320	170	4955	195	●	●	●			●		●		●	
	P125A	5750	600	12 500	24	3685	145	4510	177½	●	●	●		●	●		●			
	P150A	6850	600	15 000	24	3685	145	4510	177½	●	●	●		●	●		●			
	P165A	7500	600	16 500	24	4190	165	4990	196½	●	●	●		●	●		●			
	P180A	8250	600	18 000	24	4190	165	4990	196½	●	●	●		●	●		●			

Lift trucks

for every application

From a truly extensive range, Hyster lift trucks have proved their advanced design and dependability in the military field. Utilised for stores handling, transport supply and general movement of military goods, Hyster lift trucks' efficiency and ruggedness are proved daily in widely differing locations. Over 200 Hyster lift trucks are presently in use with the British armed forces.

Some Hyster and Hyster-Ransomes features are:

Dreyfuss functional design giving comfort and visibility for the driver
Instant access for servicing
Single-lever for lift and tilt
Single pedal control for direction and acceleration
Robust unitised frame
Fast lift speeds
Short turning radius
Choice of power options (diesel, petrol, LP-gas or battery power)
Wide capacity range from 500 kg to 28 000 kg (1000–62 000 lb).

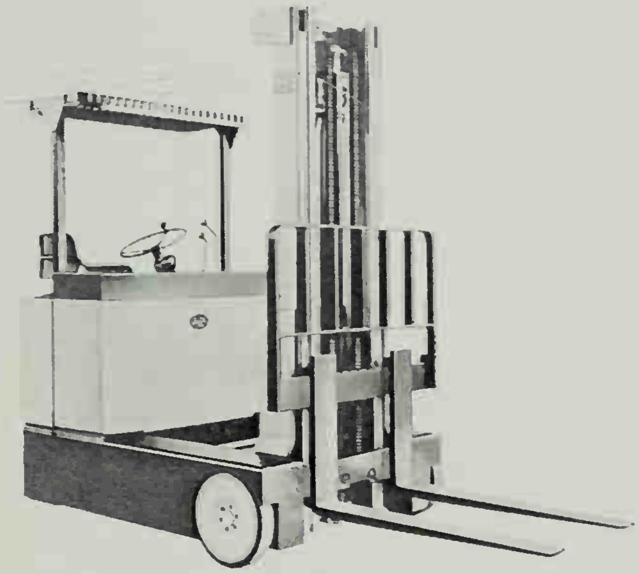
Hyster lift trucks are grouped in four ranges:

1. The SpaceSaver Range trucks have cushion tyres and are available with load capacities from 1000 kg to 6850 kg (2000–15 000 lb).

2. The Challenger Range trucks have pneumatic tyres and are available with load capacities of from 1000 kg to 28 000 kg (2000–62 000 lb).

3. The Pioneer Range are heavy-duty rough-terrain trucks with high ground clearance and fitted with grader or high-flotation tyres. Models are available with capacities from 3000 kg to 8250 kg (6000–18 000 lb).

4. The Hyster-Ransomes battery-powered lift trucks and reach trucks cover the range from 500 kg to 4000 kg (1000–8000 lb) capacity.



Above: the Hyster-Ransomes R45C reach truck has a capacity of 2310 kg at 500 mm load centre (4500 lb at 24 in load centre). It incorporates important innovations which directly and measurably influence performance and productivity. The large-diameter drive wheels, situated in the reach legs, are independently driven and the highly sophisticated Solectronic solid-state system controls traction and hydraulics with complete precision. The result: faster smoother operation; maximum traction under all conditions; outstanding manoeuvrability and effortless steering; instant positive response

The powerful Hyster Challenger H50F has a capacity of 2500 kg at 500 mm load centre (5000 lb at 24 in load centre). Here in service with the Royal Army Ordnance Corps, it is equipped with a rugged 71 SAE hp Perkins diesel engine and powershift transmission with the exclusive Monotrol pedal control system

The Hyster Challenger H200ES has a capacity of 9100 kg at 600 mm load centre (20 000 lb at 24 in load centre). This one is being operated by the Royal Naval Armament Depot. For its capacity it has an extremely short turning radius and is ideally suited to heavy-duty applications where manoeuvring space is at a premium

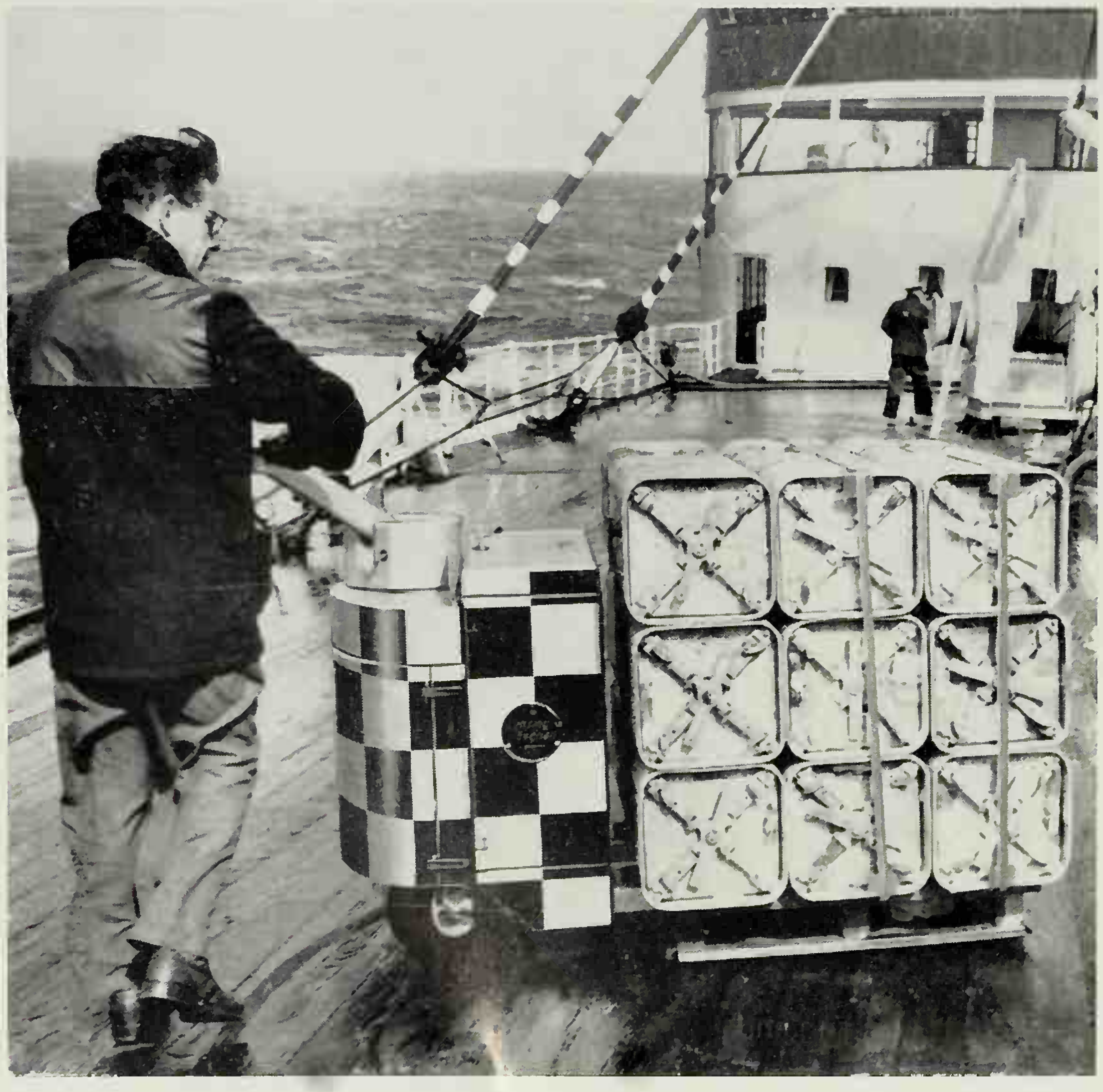
HYSTER LIMITED
Turriff Building, Great West Road, Brentford, Middlesex, England
Telephone: 01-568 9292

HYSTER

Lansing Bagnall

Narrow aisle trucks

(1) Electronic or contactor control systems
(2) Narrow aisle operation
(3) Special side-seated driving position
(4) High stacking
(5) 800–2040 kg (1760–4500 lb) capacities
(6) Five basic models
(7) Optional extras



Transporters

(1) Pedestrian or rider-controlled
(2) Electronic or contactor control systems
(3) Amazing manœuvrability
(4) Six basic models
(5) 1360–2950 kg (3000–6500 lb) capacities
(6) Stillage or pallet versions
(7) Optional extras

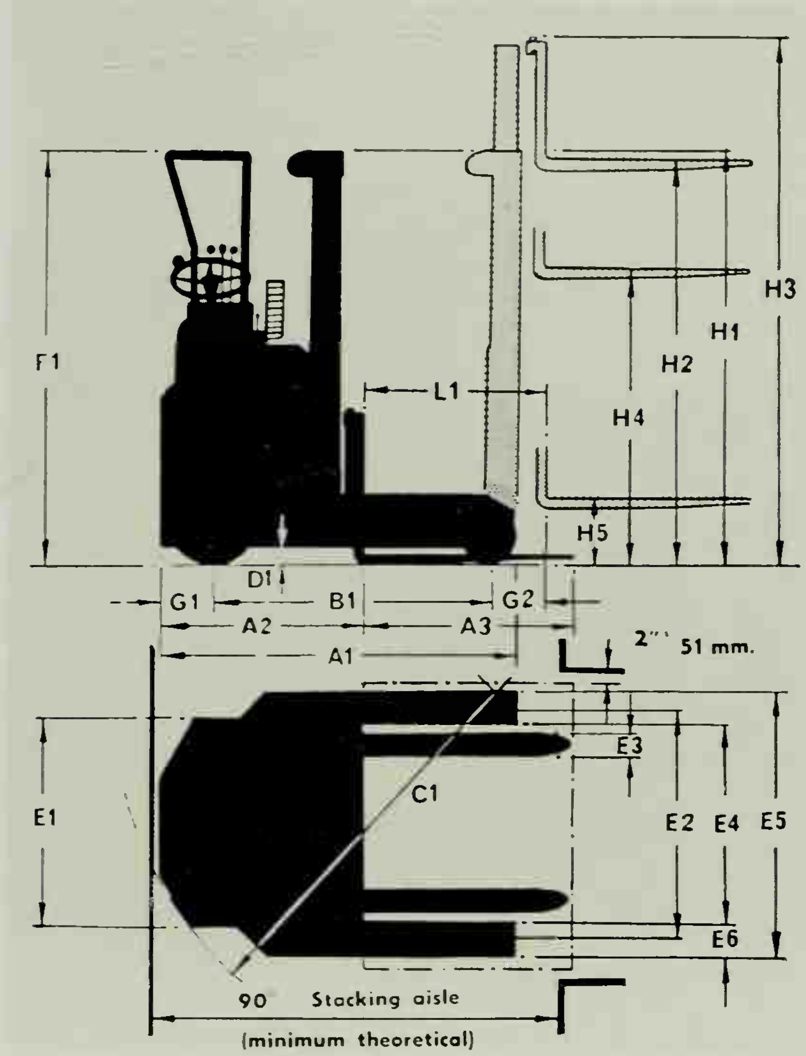
Trucks

for lifting and transporting

Typical specification

Model FRER 7

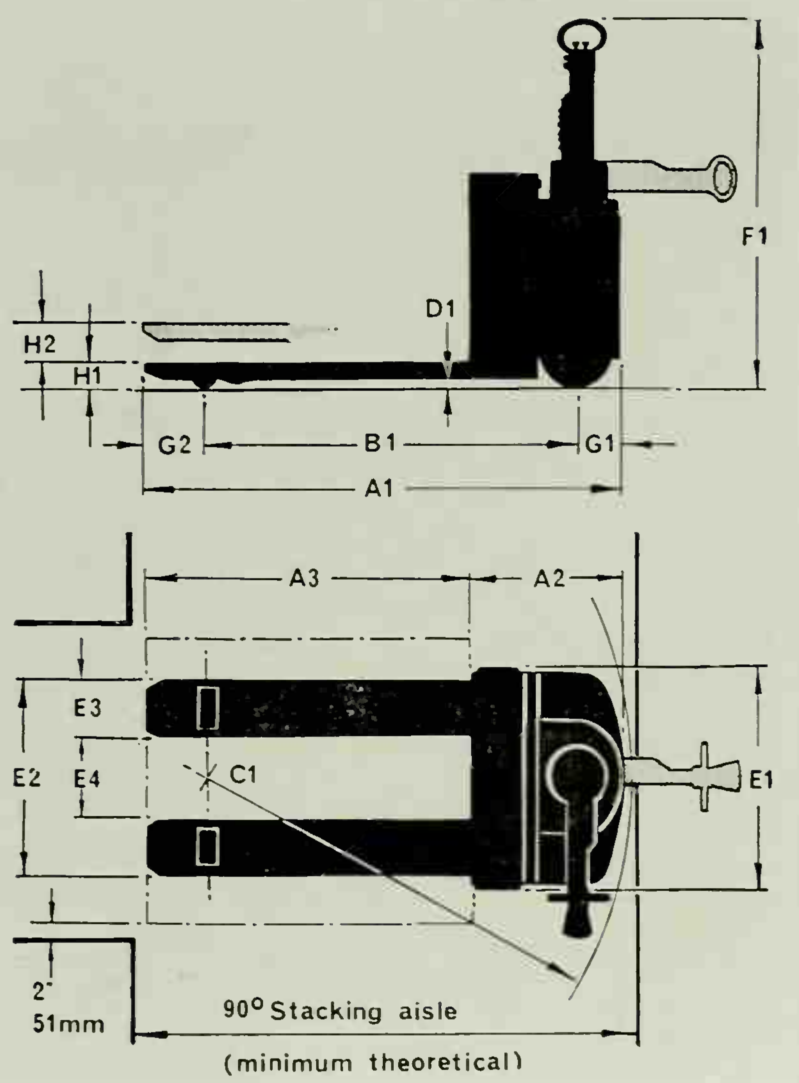
	Capacity 2040 kg (4500 lb)
	Load centre 610 mm (24 in)
A1	Overall length 1918 mm (75½ in)
A2	Rear to face of forks 1118 mm (44 in)
C1	Turning radius 1778 mm (70 in)
E1	Power unit width 1016 mm (40 in)
H1	Height of mast lowered 2108 mm (83 in)
H2	Height of std. triple lift 4430 mm (174 in), max 7620 mm (300 in)
L1	Reach travel 870 mm (34¼ in)
	Travel speed unladen 8·0 km/h (5·0 mph)
	Lift speed unladen 15·2–18·3 m/min (50–60 ft/min)
	Battery voltage/Ah 24/754
	Service weight 3062 kg (6750 lb)
	Max gradient laden 1:10


F1
L1
H3
H1
H2
H4
H5
D1
G1
B1
G2
A2
A3
A1
2" 51 mm.
E3
C1
E1
E2
E4
E5
E6
90 Stacking aisle
(minimum theoretical)

Typical specification

Model POEP 2

	Capacity 1360 kg (3000 lb) or 2040 kg (4500 lb)
A2	Rear to face of battery 451 mm (17¾ in) or 489 mm (19¼ in)
A3	Fork length 914 mm (36 in)
C1	Turning radius 1190 mm (46⅞ in) or 1228 mm (48⅜ in)
E1	Overall width 731 mm (28¾ in)
E2	Width over forks 559 mm (22 in) or 686 mm (27 in)
F1	Overall height 1435 mm (56½ in)
H1	Height of forks lowered 82 mm (3¼ in)
H2	Height of lift 152 mm (6 in)
	Travel speed laden 4·8 km/h (3 mph) or 4·0 km/h (2·5 mph)
	Battery voltage/Ah 16/167 or 16/222
	Service weight 525 kg (1157 lb) or 584 kg (1287 lb)
	Max gradient laden 1:8 or 1:10


F1
D1
H2
H1
G2
B1
G1
A1
A3
A2
E3
E2
E4
C1
E1
2"
51mm
90° Stacking aisle
(minimum theoretical)

LANSING BAGNALL LIMITED
Kingsclere Road, Basingstoke, Hampshire, England
Telephone: Basingstoke 3131
Cables: Bagnallic Basingstoke Telex: 85120

Counterbalance fork lift trucks (above)

(1) Includes the most advanced fork truck range in the world
(2) Electronic control system
(3) 680–2720 kg (1500–6000 lb) capacity
(4) Eleven basic models
(5) Cushion or pneumatic tyres
(6) Versatile and economical
(7) Optional extras

Towtractors (below)

(1) Electronic control systems
(2) Three models: TOER 4·2
227 kg (500 lb) capacity
318 kg (700 lb) capacity
454 kg (1000 lb) capacity
(3) Rear battery model TOER 8
Low battery profile TOER 8
1134 kg (2500 lb) capacity

AER LINGUS IRISH INTE

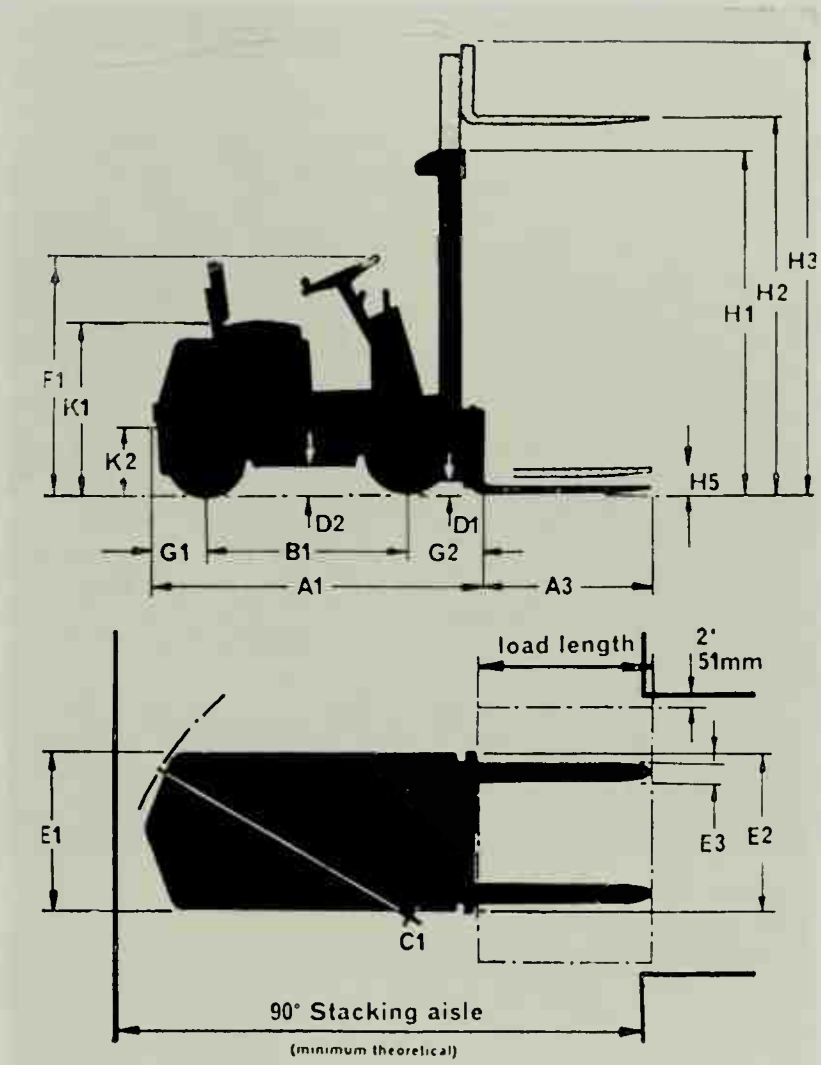
Trucks

for lifting and transporting

Typical specification

Model FOER 9/60

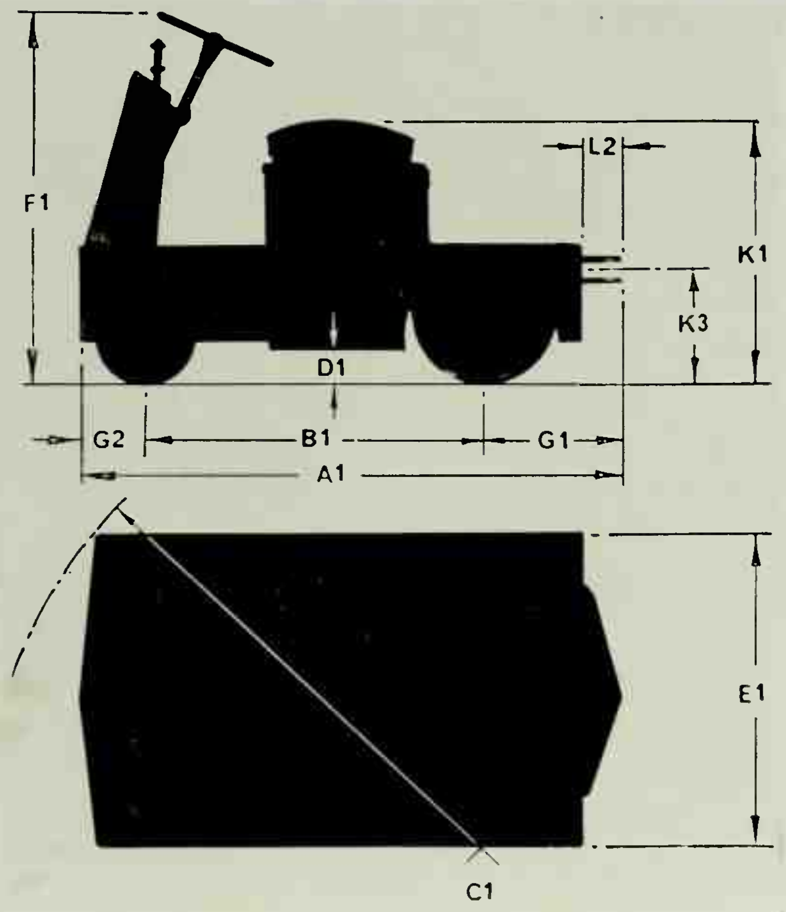
Capacity 2720 kg (6000 lb)
Load centre 610 mm (24 in)
A1 Overall length to heel of forks 2362 mm (93 in)
C1 Turning radius 2032 mm (80 in)
E1 Power chassis width 1142 mm (45 in)
G2 Centre of axle to heel of forks 419 mm (16½ in)
H1 Height of mast lowered 2108 mm (83 in)
H2 Height of lift 3048 mm (120 in)
Travel speed unladen 12·1 km/h (7·5 mph)
Lift speed unladen 35 cm/sec (70 ft/min)
Battery voltage/Ah 72/484
Service weight 4672 kg (10 300 lb)
Max gradient laden 1:8



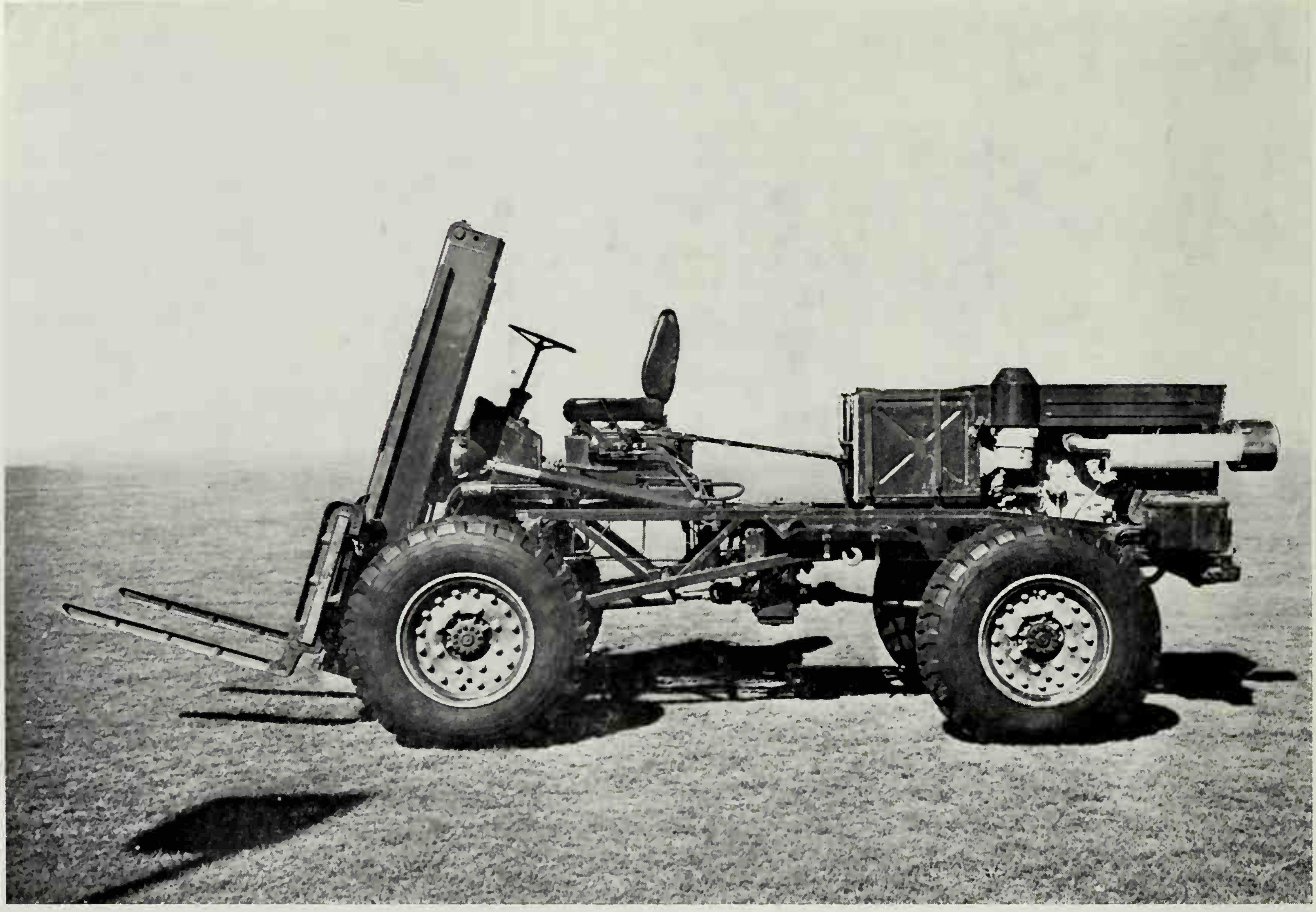
Typical specification

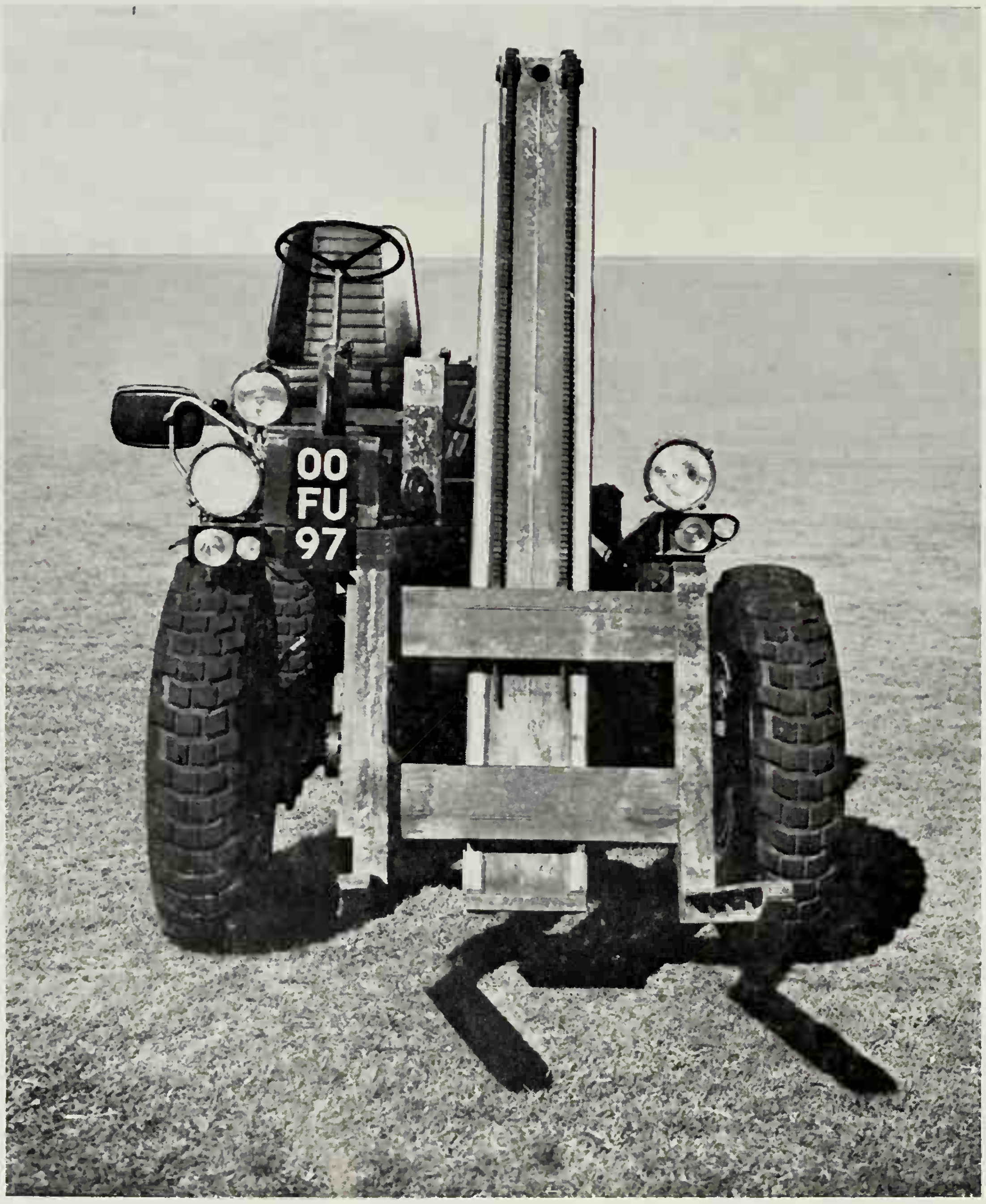
Model TOER 4·2

Max drawbar pull 318 kg (700 lb)
Sustained DBP 95 kg (210 lb)
A1 Overall length 1619 mm (63⅜ in)
C1 Turning radius 1473 mm (58 in)
D1 Underclearance 127 mm (5 in)
E1 Overall width 914 mm (36 in)
F1 Overall height 1168 mm (46 in)
K3 Height of towing bracket 387 mm (15¼ in)
Travel speed unladen 12·9 km/h (8·0 mph)
Front (steer) wheel size 406 mm (16 in) dia × 102 mm (4 in)
Rear (drive) wheel size 406 mm (16 in) dia × 102 mm (4 in)
Battery voltage/Ah 48/145
Service weight 726 kg (1600 lb)
Max gradient unladen 1:5



LANSING BAGNALL LIMITED
Kingsclere Road Basingstoke, Hampshire, England
Telephone: Basingstoke 3131
Cables: Bagnallic Basingstoke Telex: 85120





In industrial storage areas space is at a premium and the ground is usually paved. Industry-derived fork lift trucks therefore have a short overall length and high weight to balance the load. The same balancing moment can be achieved with a much lower total weight by extending the length.

In the open terrain in which field equipment operates space is usually plentiful whereas mobility depends on low specific weight. The Eager Beaver is the first materials handling vehicle to be designed with this basic fact in mind.

The Eager Beaver fork lift tractor is a significant contribution to airborne operations and to logistic practice in general.

The top illustration shows the simple fabricated chassis, high ground clearance, excellent access to engine and lifting mechanism and the simple arrangement of the four-wheel drive and steering mechanism.

The illustration left shows the offset single-beam mast and offset driving seat. This not only affords an unobstructed view of load and road to the driver, but allows the mast to be folded back for air transportation or high-speed travel on roads.

Eager Beaver

rough-terrain fork lift tractor

The Eager Beaver fork lift tractor was specifically designed for the handling of military loads in difficult terrain, including soft sand, deep mud and all uneven surfaces. Air-portability was an important design parameter, resulting in the low profile and light weight of the unit without sacrifice in load-carrying capacity.

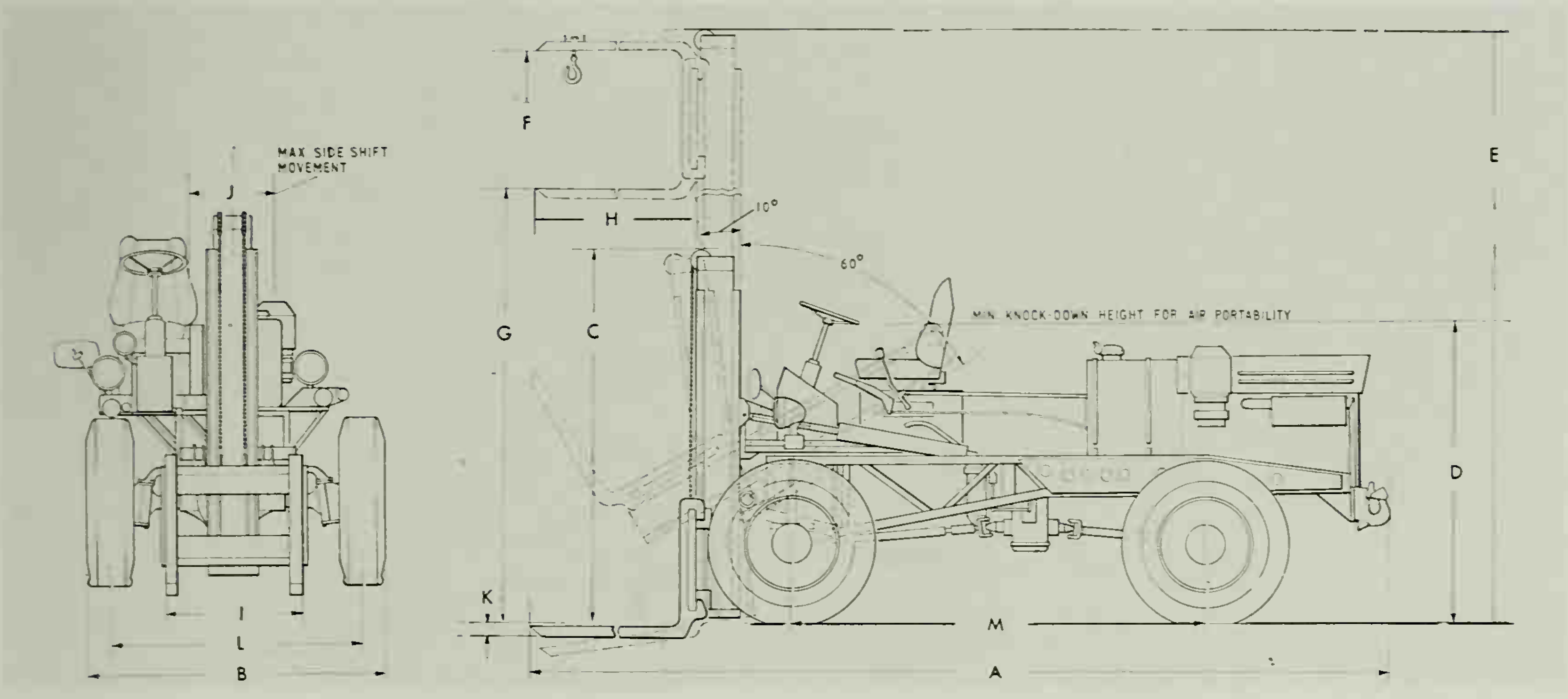
To cope with rough conditions, the 78 hp Perkins engine delivers power to all four wheels, each equipped with a high-flotation 11 × 20 Michelin XL tyre with aggressive cross-country tread. Air-dropped pallets previously written off can now be recovered with ease as a routine operation.

The truck has outstanding handling performance ensured by major advances in fork lift truck design. The combination of the single-beam mast and the driver's seat located to one side of the vehicle gives the operator a full view of the load and forks.

Despite its load capacity of 1820 kg (4000 lb), the truck weighs only 2657 kg (6100 lb) and has such a low overall profile that with few adjustments it can fit snugly into the Andover aircraft.

The vehicle's low total weight and powerful engine give excellent acceleration and a top speed of over 64 km/h (40 mph). It will be a pace-setter in the convoy and allows a rapid switch of handling resources.

To simplify distribution problems at the airhead, Eager Beaver can pull the 5-ton air-portable cargo trailer (ACT 5) singly or in a pair. An aircraft can now be swiftly unloaded on to the trailers, leaving it free to depart while the loaded trailers are towed to the stores area. The trailer has been designed to be dismantled into a compact package so that it can be carried in the smallest transport aircraft.



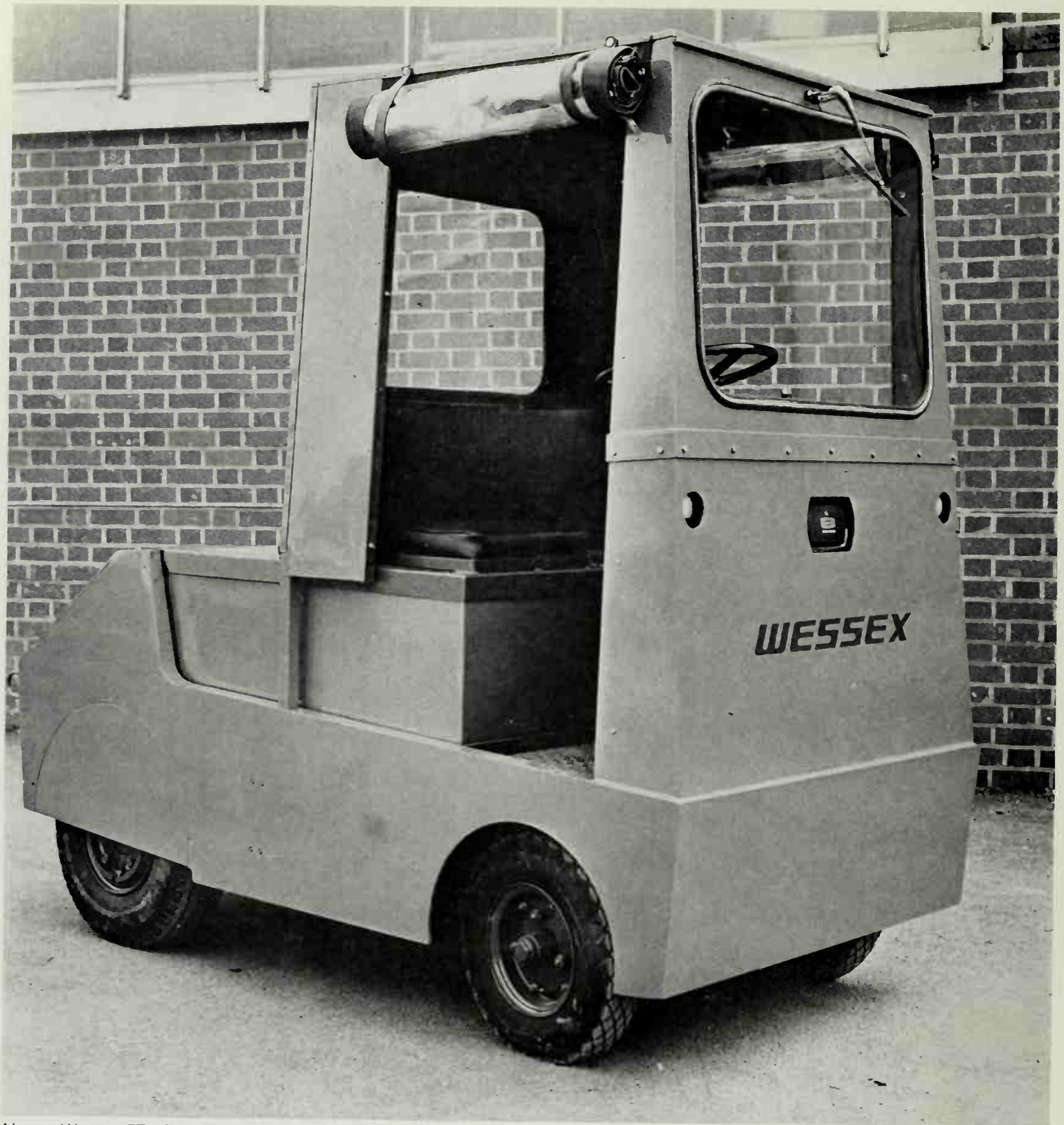
Specification

Engine: Perkins 4·236, four-cylinder diesel
Power output: 78 bhp at 2500 rev/min
Clutch: 330 mm (13 in) Borg & Beck dry clutch
Gearbox: Bedford RL, 4 forward, 1 reverse speed
Aux gearbox: Thornycroft combined speed-change and 2/4-wheel drive
Axles: Bedford RL steer-drive, front and rear
Tyres: Michelin XL 11·00 × 20, inflated to 1·76 kg/cm^2 (25 lb/in^2) front, 1·05 kg/cm^2 (15 lb/in^2) rear
Brakes: four-wheel hydraulic main brakes, mechanical transmission disc parking brake
Steering: hydraulic power-steering on 2 or 4 wheels with Orbitrol control valve
Electrical system: 24 V negative earth, two batteries 12 V, 100 Ah each, 15 A alternator, electric starter, all lamps
Hydraulics: gear-driven gear pump delivering 82 litres/min (18 gal/min) at 7124 kgf/cm^2 (2500 lbf/in^2) and 16 litres/min (3·5 gal/min) at 3700 kgf/cm^2 (1300 lbf/in^2), preferentially to steering
Weight, unladen, air-portable: 2560 kg (6083 lb), of which 1230 kg (2709 lb) on front axle and 1530 kg (3374 lb) on rear axle
Chassis: lightweight space frame fabricated in high-tensile steel rectangular tube to British Standard 4360:1968
Seat: waterproof, padded, fully adjustable

Dimensions
A—Overall length: 5500 mm (213·75 in)
B—Overall width: 1854 mm (73 in)
C—Overall operational height: 2388 mm (94 in), forks lowered, mast vertical
D—Overall air-portable height: 1829 mm (72 in), mast folded back
E—Max height: 3708 mm (146 in), mast fully raised
F—Height to hook: 3250 mm (128 in), with forks inverted
G—Max lift of forks: 2737 mm (107·75 in)
H—Effective length of forks: 1120 mm (44·125 in)
I—Spread of forks: 787 mm (31 in) max; 533 mm (21 in) min
J—Side shift of forks: 152 mm (6 in)
K—Fork section: 82 × 70 mm (3·25 × 2·75 in)
L—Track, front and rear: 1550 mm (61 in)
M—Wheelbase: 2540 mm (100 in)
Turning circle: two-wheel steering 15·17 m (47 ft 10 in); four-wheel steering 9·19 m (30 ft 2 in)
Load centre: 610 mm (24 in)
Mast tilt: forward 13°, backward 20° operational, 60° for air-portability

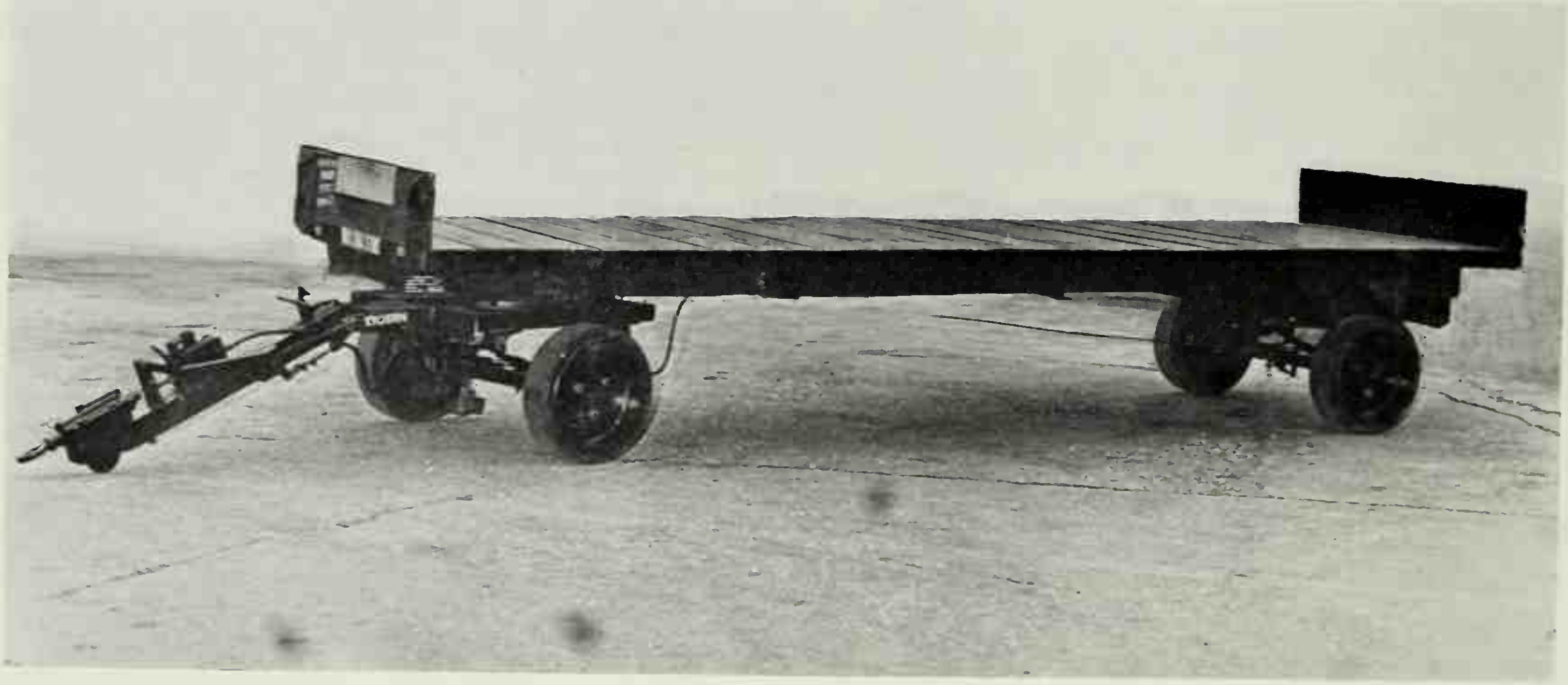
Performance
Load capacity: 1814 kg (4000 lb)
Laden lift speed: 24·38 m/min (90 ft/min)
Speeds: forward 64 km/h (40 mph) on road, up to 24 km/h (15 mph) on rough terrain, reverse 11 km/h (6·7 mph)
Gradability laden: 1 in 2·5
Fording depth: 760 mm (30 in) without preparation

MINISTRY OF DEFENCE
Director of Sales (Army)
St Christopher House, Southwark Street, London SE1, England
Telephone: 01-928 7999



Above: Wessex ET 500 battery-electric tractor

Below: Wessex 3-ton capacity trailer



Tractors, trucks, trailers

for handling military stores

Wessex Industries has been a supplier to the British Ministry of Defence for many years now. Each year new models, all built to Ministry specifications, are added to the range available.

Broadly, the range consists of lift trucks, reach trucks, platform trucks, tractors and trailers.

The trailers vary in length from 2·44 m (8 ft) to 7·32 m (24 ft) and in width from 1·22 m (4 ft) to 1·83 m (6 ft). They are fitted with hardwood or chequerplate platforms.

The trailer shown at the left is the Wessex 3-ton capacity trailer with hardwood platform, measuring 3·96 × 1·22 m (13 × 4 ft). It is fitted with solid rubber anti-static tyres and has a hydraulic braking system on all wheels.

The range of tractors includes the Wessex ET 500, shown at the top left, which has a sustained pulling power of 227 kg (500 lb) and a maximum draw bar pull of 1180 kg (2,600 lb). It is a battery-electric, open-sided model, fitted with windscreen and electric wiper and clear pvc side curtains. Accessories include side and tail lights, headlamps and pneumatic tyres.

Lastly, there is an extensive range of lift trucks, with mast lifts of 3·66, 3·96 and 4·27 m (12, 13 and 14 ft), with mast closed heights of 2·13, 2·29 and 2·44 m (7, 7½ and 8 ft).

Most of these trucks have standard accessories of side lights, tail lights, spotlamps and pneumatic tyres and laden speeds of 8 to 9 km/h (5 to 5½ mph).

The lift truck shown at the right is the Wessex FE 50-24 battery-electric lift truck with a three-stage mast assembly. It incorporates a device which automatically weighs the load on the forks. The truck is also fitted with power-assisted steering, side and tail lights, direction indicators, twin spotlamps, and a side-shift mechanism on the forks. Lift height is 3·96 m (13 ft) overall and closed mast height is 2·23 m (7 ft 4 in).

Many variatons are available and detailed literature will be supplied on request.

Wessex FE 50-24 battery-electric lift truck

WESSEX INDUSTRIES LIMITED
Market Street, Poole, Dorset, England
Telephone: Poole 2626 Cables: Industries Poole

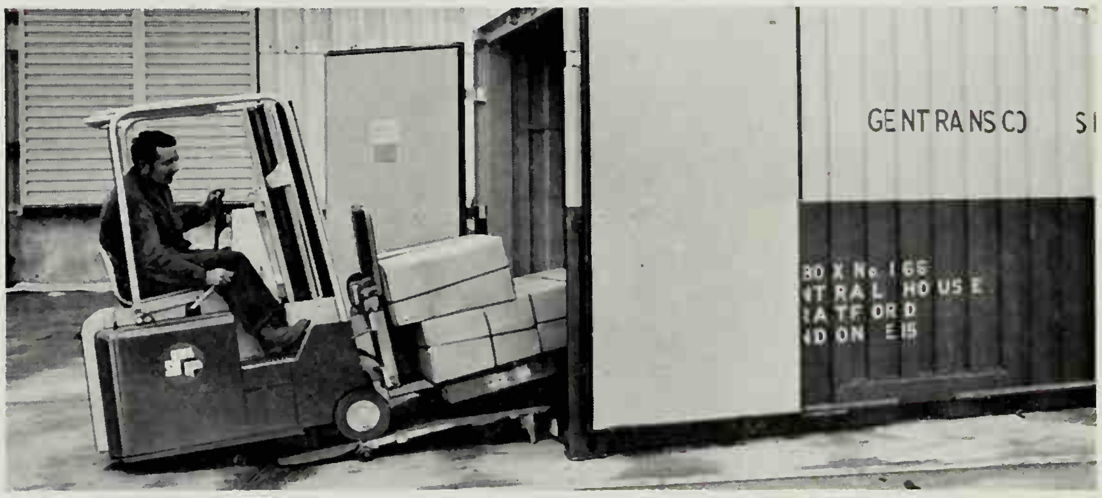
WESSEX

Fork lift trucks

with capacities from 140 kg to 1360 kg (300-3000 lb)

In the field of mechanical handling equipment, Hestair Sherpa is regarded as specialist in the production of light and medium-range fork lift trucks and precision hydraulic lifting tables.

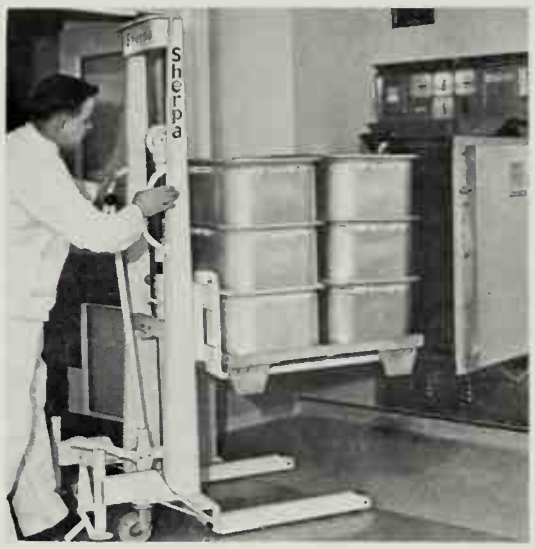
No other manufacturer supplies such an extensive range of lifting equipment suitable for the very widest range of handling applications. For lifting and shifting, Hestair Sherpa fork lift trucks efficiently save time, money and space.

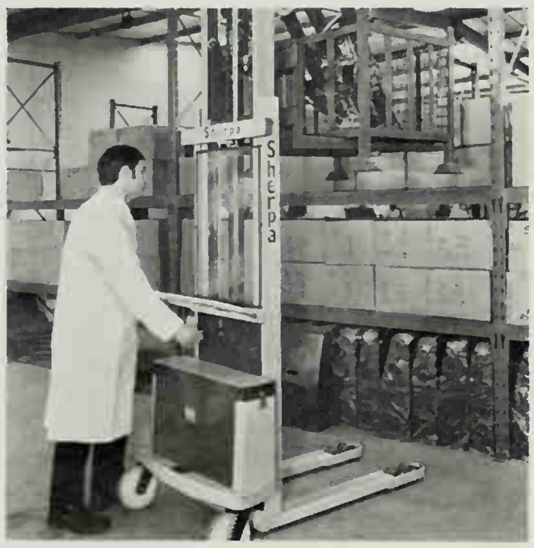


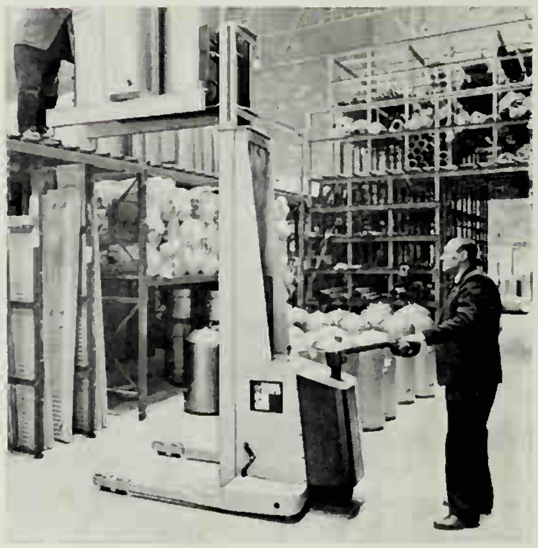
1. 1000 Series: Sherpa Peg Micro

six full-scale compact battery-electric fork lift truck models

Illustrated:
Capacity 1010 kg at 500 mm (2240 lb at 20 in)
Length (without forks) only 1328 mm (52¼ in)
Width 916 mm (36 in)
Heights of lift to 4800 mm (189 in)
Lowered heights 1800 mm (70 in)
Weight from 1580 kg (3480 lb)
Telescopic models available—double or triple lift all with full free lift







2. 300 Series

49 manual and electro-hydraulic power-lift models

Illustrated:
300 Model
Capacity 360 kg at 400 mm (800 lb at 16 in)
Length 1257 mm (49½ in)
Width 771 mm (28 in)
Height collapsed 1905 mm (75 in)
Height extended 2032 mm (80 in)
Length of forks 762 mm (30 in)
Lift height 1524 mm (60 in)

3. 400 Series

two hand-propelled models with electro-hydraulic power lift for the larger pallets

Illustrated:
460 Model
Capacity 500 kg at 610 mm (1100 lb at 24 in)
Height of lift 1524 mm (60 in)
Length 1613 mm (63½ in)
Width 825 mm (32½ in)
Height collapsed 1930 mm (76 in)
Height extended 1956 mm (77 in)
Length of forks 1016 mm (40 in)
Model 480 (telescopic type
lifting to 2692 mm (106 in)

4. 600 Series

eight power-propelled battery-electric fork lift truck models

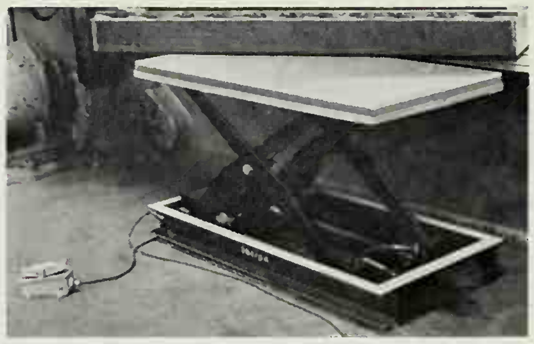
Illustrated:
610 Model
Capacity 1010 kg at 500 mm (2240 lb at 20 in)
Lift height 1524 mm (60 in)
Fork lowered height 89 mm (3½ in)
Fork adjustment (outside) 261/533 mm (8½–21 in)
Fork length 914 mm (36 in)
Width 685 mm (27 in)
Length 1829 mm (72 in)
Telescopic models are available
(with full free lift)
lifting to 3658 mm (144 in)

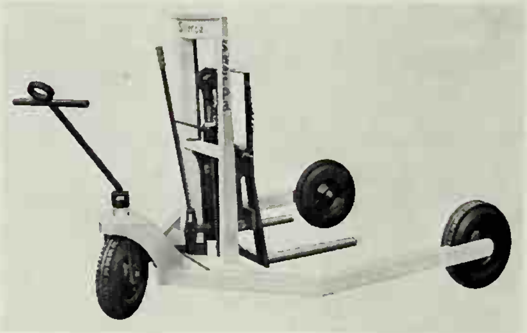
5. Lifting tables

Precision-built mobile or static models with 450–2270 kg (1000–5000 lb) capacities and lift heights from 1065 mm to 2000 mm (42–79 in)
Many variants are available, both of the manual and mains-electric type

6. New aero truck

Speeds ground servicing (particularly wheel changing) on large aircraft and wheeled vehicles. Incorporating the Sherpa Handraulic lifting system, it has a 270 kg (600 lb) load capacity and is available with interchangeable attachments.





HESTAIR SHERPA LIMITED
Southall Lane, Hounslow, Middlesex, England
Telephone: 01-573 3844   Cables: Hestairco Hounslow

Pneumatic and solid tyres

Avon designs and manufactures a range of industrial tyres, both solid and pneumatic, to the exacting specifications of truck manufacturers and users.

Avon 'Cushion' tyres offer exceptionally low rolling resistance and greater resilience. 'Avothane' solid tyres and 'Armadillo' pneumatic tyres have been designed for fork-lift handling equipment to give long, trouble-free service under arduous conditions.

Avon 'Cling' solid tyres were developed for military supply depots and for industrial use under wet conditions, particularly where slopes or steep ramps have to be negotiated safely. Avon solid tyres can be made in special compounds, such as anti-static, electrically conducting to BS.2050, also anti-chip, oil-resisting and wet-grip (Cling).

Avon Rubber Co Ltd
Melksham, Wiltshire, England
Telephone: Melksham 3101
Cables: Rubber Melksham
Telex: 44142

Iron Fairy fast, mobile hydraulic cranes

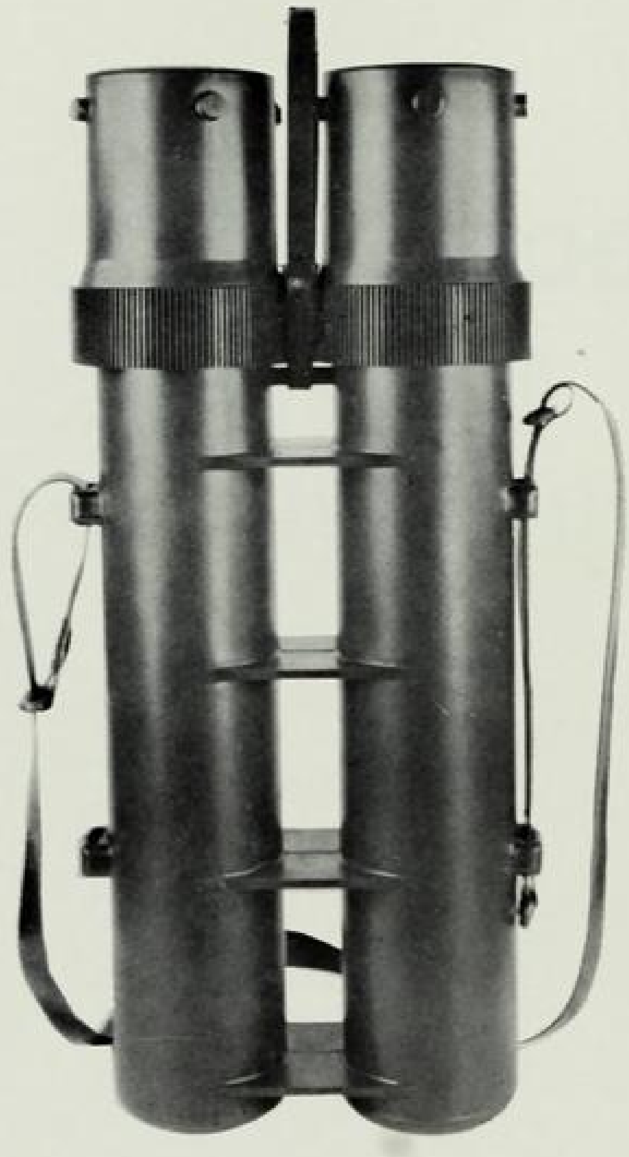
There are seven different hydraulic cranes in the *Iron Fairy* range. They lift up to 10 tons and have jib lengths from 6·4 to 24·4 metres. Their jib telescoping, derricking, hoisting and 360° slewing are all hydraulic. They are fully equipped for road travel at up to 48 km/h and one 10 ton model for up to 74 km/h.

The cranes are ready for immediate operation and are fast, smooth, and precise. Their compactness and manoeuvrability enable them to work in confined workshops as well as in open areas. They are robust, suitable for all climates and are used world-wide by industry and government departments. Many are in service with the British Army, Navy and Air Force.

The British Hoist and Crane Co Ltd
Compton, Newbury, Berkshire, England
Telephone: Compton 301
Cables: Brithoist Compton Newbury
Telex: 84358

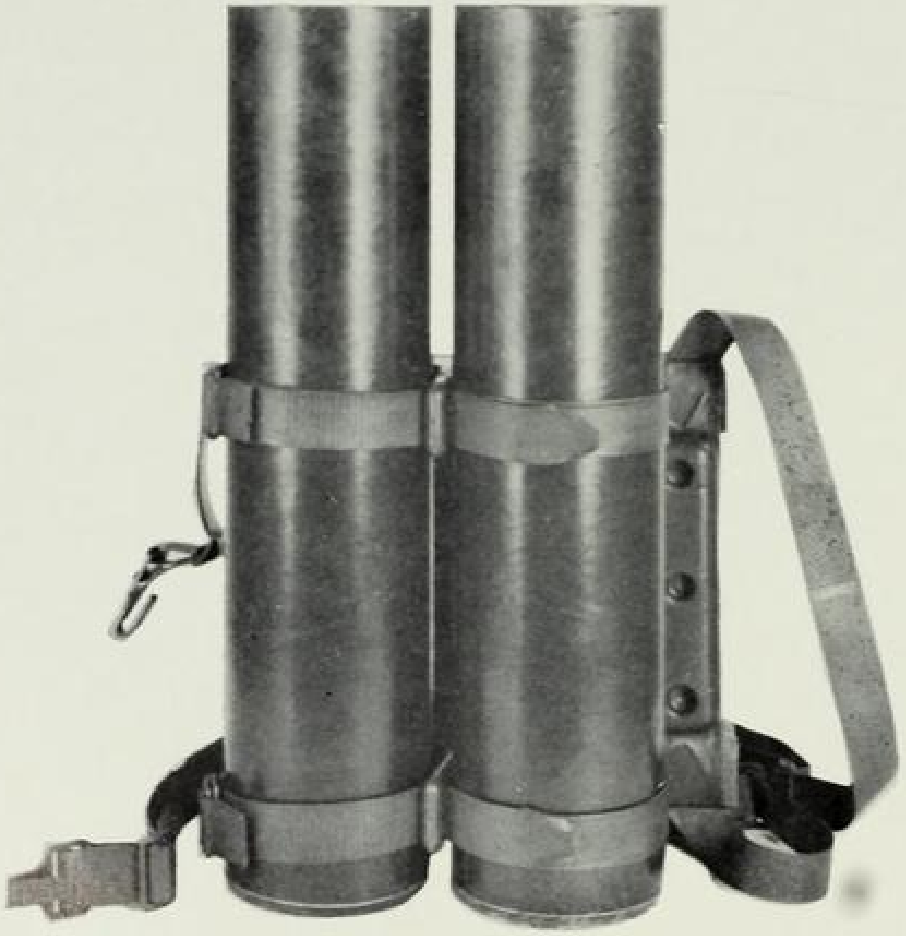
Section 33

Storage equipment



Injection-moulded ammunition containers in high-density polythene

The two closed-end type ammunition containers shown at the left are moulded together as a paired unit by means of integral lateral supporting struts. Lugs to which the harness is attached are also an integral part of the mouldings. The carrying harness is of PVC-coated glass fibre



Ammunition containers made of kraft/polythene/kraft laminate to Spec. L10226

The illustration shows two open-ended ammunition containers securely held together by means of suitable cradling and a carrying harness assembly

Ammunition containers

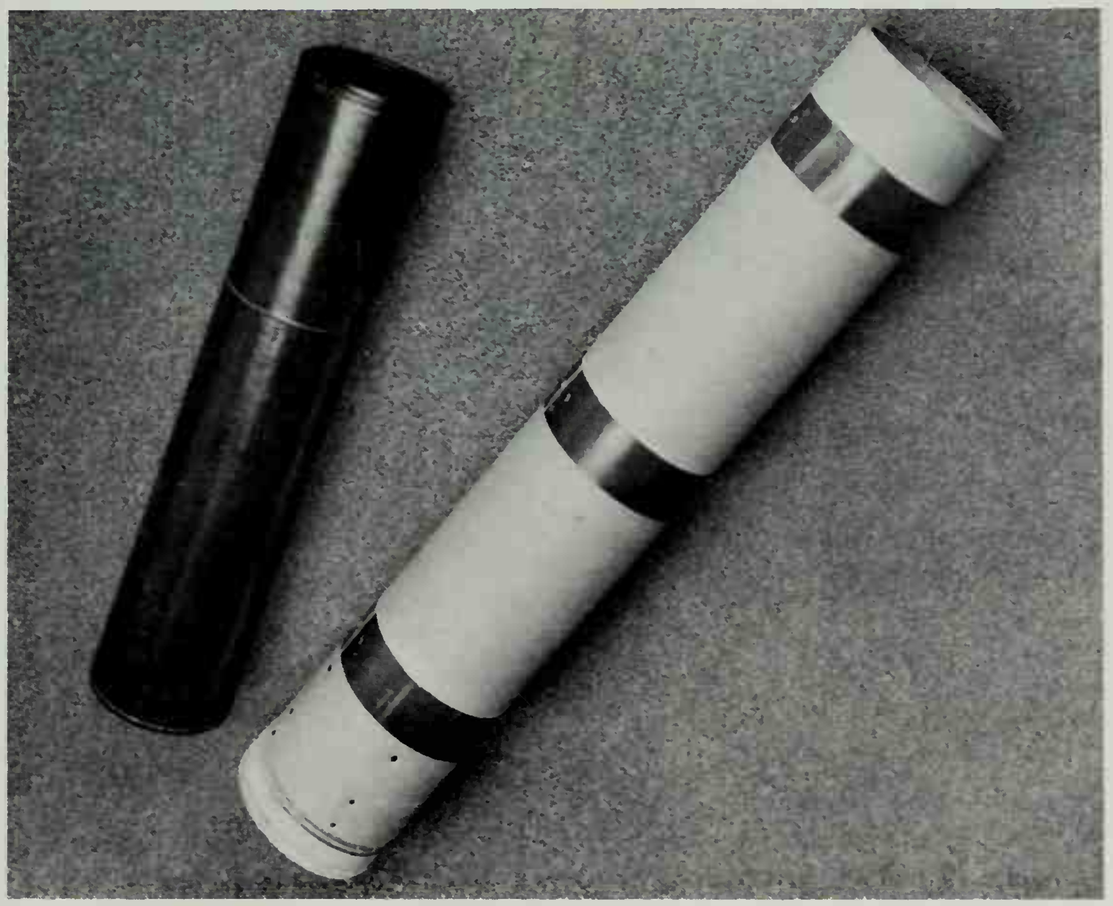
for storage and transit

Chiltern Hunt Ltd are leading manufacturers of an extensive range of packaging products and have been contractors to the British Government for over 25 years.

In addition to injection-moulded containers designed and tailored to the precise needs of customers' products the company can supply protective and flexible packaging in paper, fabric, film or foils. Complete harnesses for transporting packaged items can also be supplied to specific requirements and enquiries on packaging problems of all kinds are welcomed by the company.

Ammunition containers

Open or closed-end types of containers for ammunition packaging can be supplied manufactured from kraft/polythene/kraft laminations to Specification L10226. The manufacturing range covers diameters from 12·7mm to 152·4mm (½in to 6in). The containers are available to any length to suit individual requirements, together with internal fittings necessary to ensure protection in transit. Open-end transit tubes of all types are made to the same specification.



Injection-moulded containers

Available in high-density polythene, low-density polythene, polypropylene or PVC. Complete service from design to finished containers. Moulding range from 57·6g to 1·84kg (2oz-64oz)

Flexible packaging

Sheets, bags, liners and pouches can be supplied in polythene, PVC and anti-static film. Specialists for the supply of ethyl-vinyl-acetate co-polymer film (carbon-filled or unfilled)

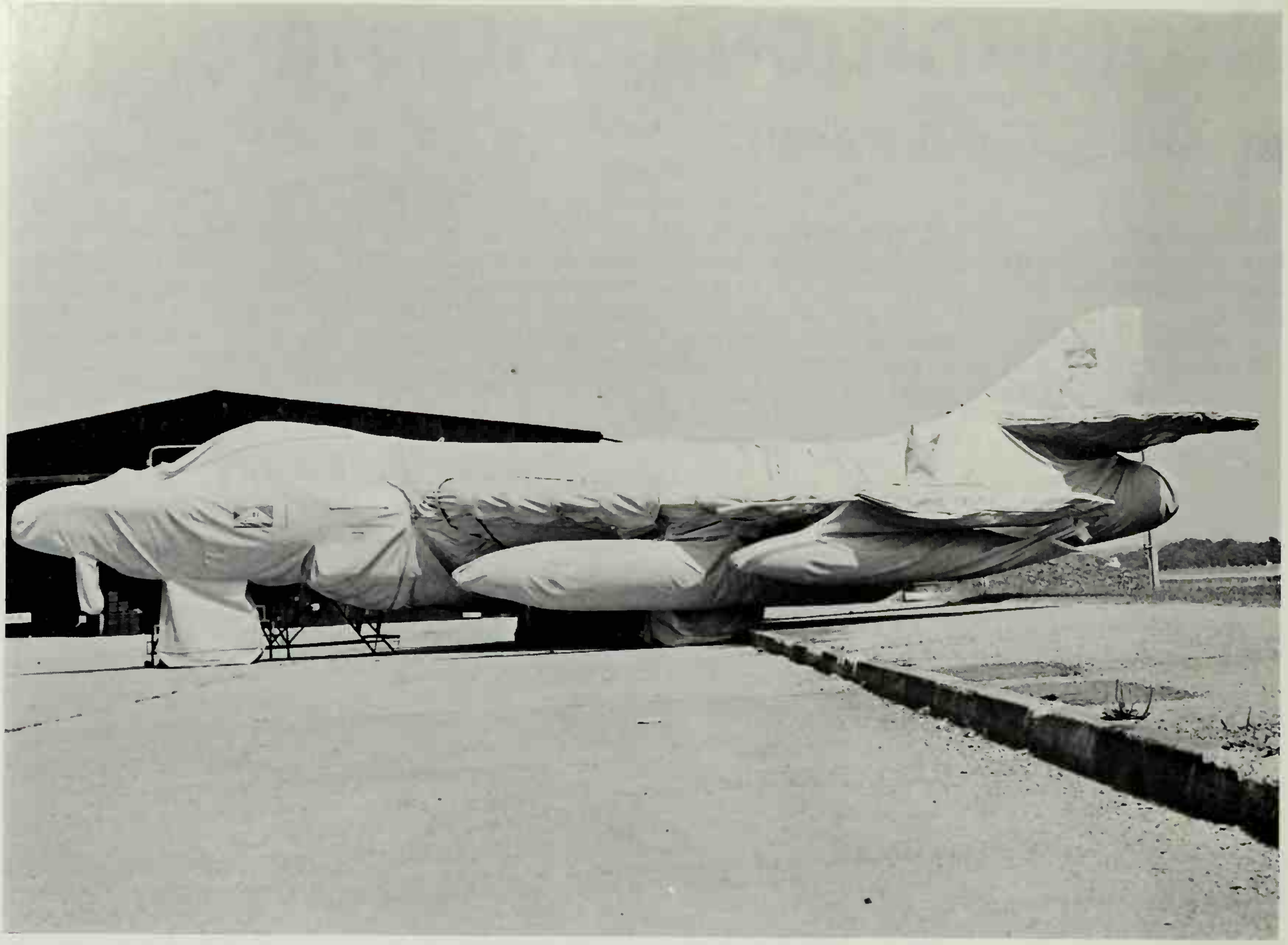
Webbings

PVC-covered glass fibre webbing can be supplied in random and cut lengths or in the form of complete harness assemblies

Protective packaging materials

A wide range of protective packagings, coated or laminated from paper, fabric and foils are available in reels, sheets or pouches

CHILTERN HUNT LIMITED
Belswain Lane, Hemel Hempstead, Hertfordshire, England
Telephones: Hemel Hempstead 51511 and King's Langley 3264 Cables: Chiltern Hemel Hempstead



1. Hawker Hunter aircraft protected by Driclad

2. Tanks protected by Driclad in stage one readiness in Europe

3. Shelter constructed from Driclad used to protect ammunition, explosives, hospital supplies, rations, etc

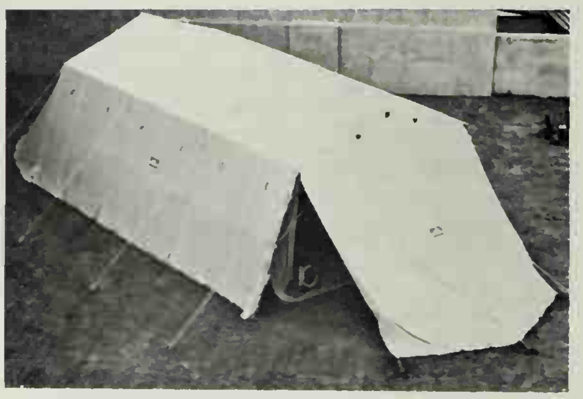
4. An EMI oscilloscope in Driclad, ready for instant use

5. Aero-engine protection by Driclad

6. Three Hawk missiles protected by Driclad as supplied to NATO forces

2

3



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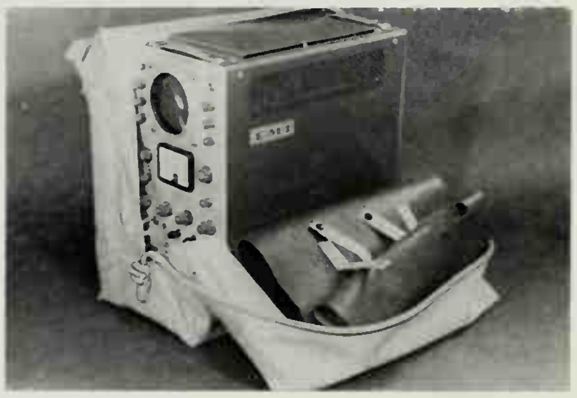

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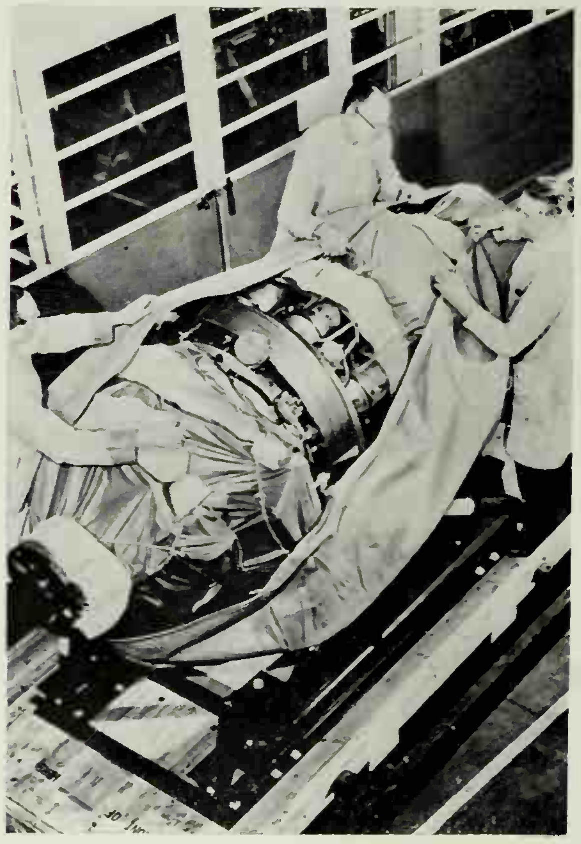


6

Operational storage

Protective system for valuable equipment

The Driclad system is the result of many years of applied research into the causes of corrosion and deterioration of equipment during storage and transit. The study of conventional methods of achieving protection against damage caused by the presence of humidity, chemical gases, salt-laden air, sand, dust, fungus and insect attack has resulted in the development of an entirely new method of protection.

It is based on the enclosure of valuable equipment in dry air contained within a flexible plastics cover. The cover is reusable and provides an effective barrier to the transmission of moisture and water vapour under extreme conditions of climate, temperature and humidity; at the same time, it gives full protection against other physical and biological hazards. It enables equipment to be transported, left or stored in the open or in non-air-conditioned structures anywhere in the world.

Maintenance requirements are reduced to almost nothing with the use of the Driclad system and protection against deterioration from rust and the effects of sand is complete. No special preparation is required, and equipment is ready for operational use at all times.

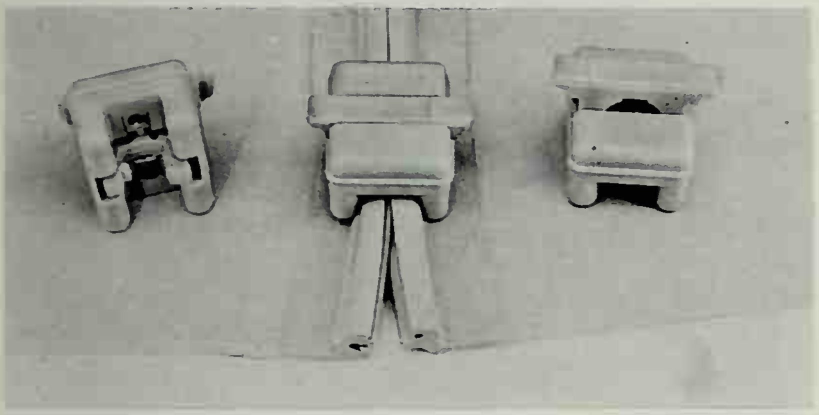
Specification

Components

The Driclad system is available in a temperate/tropical or arctic material. An anti-static material is used for equipment containing propellant, where accumulation of 'static' is unacceptable.

Closure

The Drilok closure, having the same properties as the Driclad material, consists of two interlocking plastics extrusions which are attached to the material by welding. The closure can be of a predetermined length, or it can be joined to itself to form an endless run, or it can be T-junctioned at right angles.



Driclad protection ensures:

1. Reduced maintenance costs
2. Reduced replacement costs
3. Reduced repair costs
4. Reduced manpower requirements
5. Complete protection from deterioration
6. Equipment maintained in original condition indefinitely.

For one tank park in the British Army only two men look after 80 tanks and keep them at permanent operational readiness.

The Driclad system consists of:

1. Sand and moisture-proof cover with a special closure
2. A dehumidifying chemical or machine
3. A humidity indicator

Each cover:

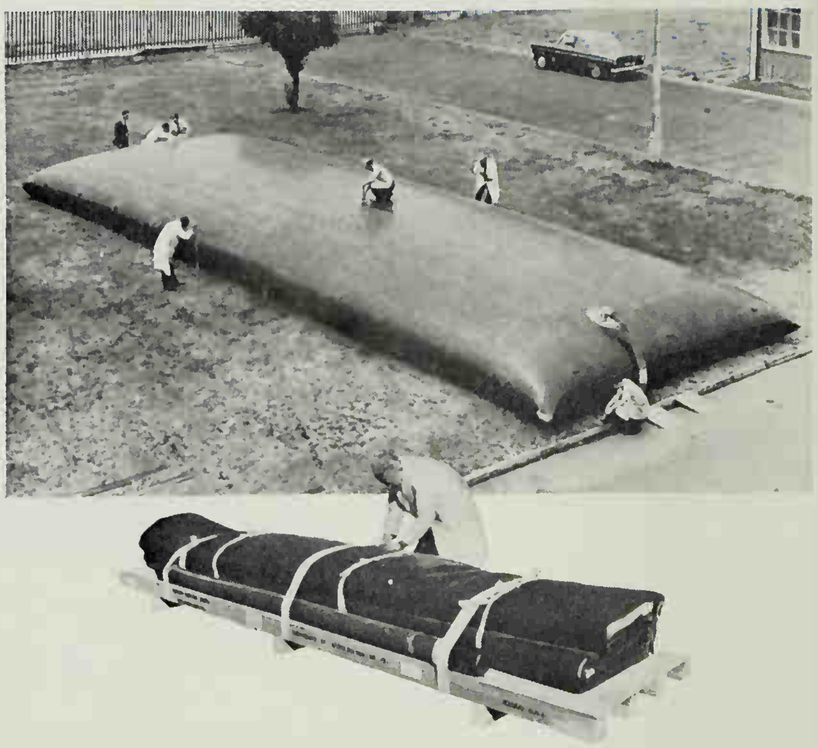
1. Is re-usable
2. Can be opened and closed simply
3. Does not require technical skill to use
4. Will last anything from five to ten years
5. Will enclose equipment of any shape

DRICLAD LIMITED
Staplehurst Road, Sittingbourne, Kent, England
Telephone: Sittingbourne 4422 Cables: Expac Sittingbourne
Telex: 96180

A member of the Export Packing Service group of companies

Special storage equipment

Flexible reservoirs and armament packs



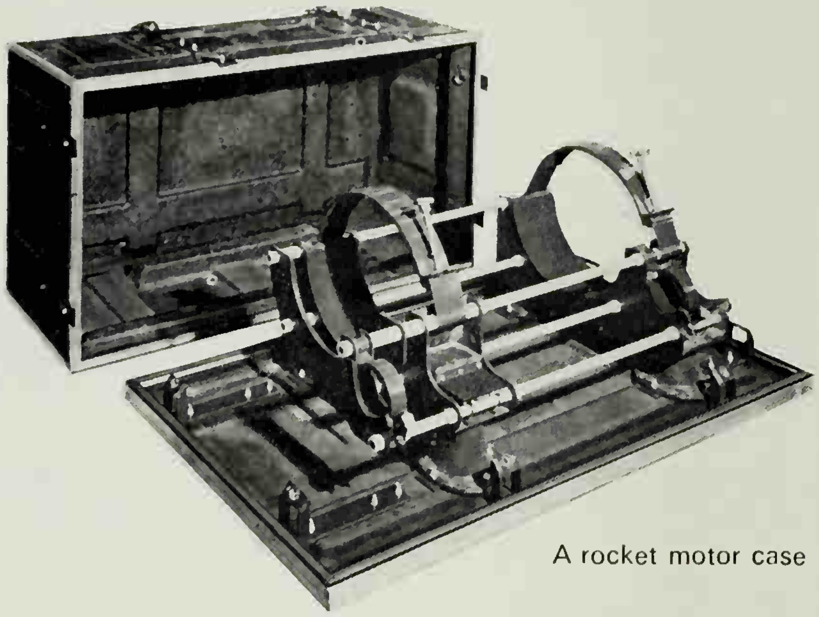
Portolite tanks
Marston Portolite tanks are flexible liquid containers, made from fabric-reinforced rubber materials, which make the storage of liquids possible anywhere there is a flat area of ground. These tanks are particularly useful for the storage of petrol or kerosene on temporary airstrips or forward landing areas for VTOL aircraft. When not in use a Portolite tank can be rolled up into a small bundle and stored or transported as required.

Portolite tanks are made in capacities from 2270 to 136 400 litres (500 to 30 000 gal). Tanks from 2270 to 13 640 litres (500 to 3000 gal) capacity can also be used for the transport of liquids on lorries or rolling stock.

The external surface of the tanks has a high degree of resistance to abrasion, ozone, sunlight and petroleum. The material has a tensile strength of 70 kg per 1 cm (400 lb per 1 in) wide strip—ten times the load applied to the largest tank made.

Standard capacities (gal): 500, 750, 1100, 1350, 1600, 1800, 2000, 3000, 5000, 10 000, 20 000 and 30 000.

Dimensions of a 30 000 gal tank:
Full 13·4 × 8·2 × 1·8 m (44 ft × 27 ft × 6 ft)
Folded 4 × 0·76 × 0·76 m (13 ft × 30 in × 30 in)



A rocket motor case

Armament packs
Marston Excelsior Limited has full engineering facilities for the manufacture of special armament packs involving fabrication in reinforced plastics, reinforced rubber and aluminium alloys.

We can supply to specific designs robust, lightweight packs made from reinforced plastics and aluminium which incorporate reinforced rubber sealing covers for the environmental protection of the equipment.

With many years of experience in the field of reinforced plastics fabrication, Marston Excelsior is well versed in the latest production techniques with facilities for the spray deposition of resin/glass fibre laminate, matched die moulding, vacuum bag forming and press moulding.

Another facet of Marston Excelsior's production capabilities is the flexible container facility built up over many years for the manufacture of flexible fuel tanks for aircraft. The specialised knowledge and skills involved in this type of work are ideally suited to the production of the reinforced rubber covers necessary for some packs.

Coupled with metal fabrication and general engineering workshops these special facilities enable Marston to produce in quantity, under one roof, packs combining widely different materials and manufacturing techniques.

Flexible sealing covers

A subsidiary of Imperial Metal Industries Ltd

MARSTON EXCELSIOR LIMITED
Wobaston Road, Fordhouses, Wolverhampton, Staffordshire,
WV10 6QJ, England
Telephone: Fordhouses 3361 Cables: Marex Wolverhampton Telex Telex: 33211

Marston

Desiccants

Sorbsil brand silica gel is a basic desiccant capable of adsorbing at least 27 percent of moisture at 50 percent relative humidity and 25°C and is manufactured and tested to conform to all British Government and British Standard Specifications. Its function as a protection aid against moisture and corrosion in the packaging of electronic, optical and military equipment has been established over the years. The product is available in permeable bags and sachets ranging from 10 g to 10 lb which are overpacked in conveniently sized tins and drums. Official release procedures as laid down by the various inspection authorities are complied with and appropriate certificates are issued when required.

Joseph Crosfield & Sons Ltd
PO Box 26, Warrington, Lancashire, England

Telephone: Warrington 31211

Cables: Crosfields Warrington

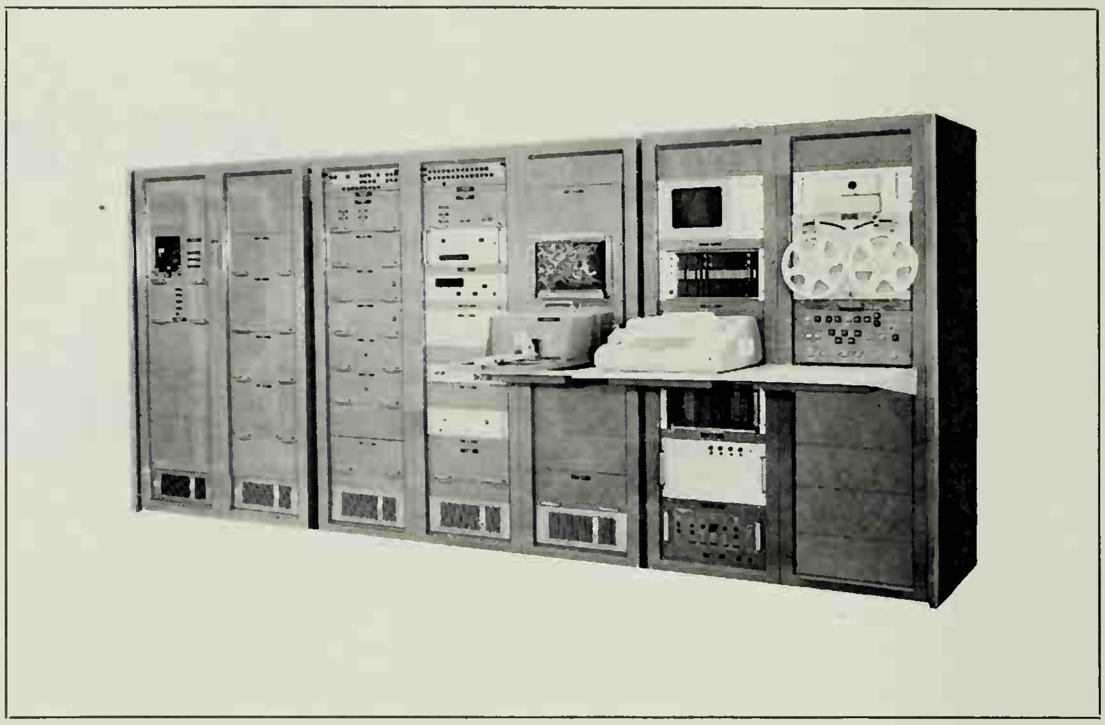
Telex: 627067

Section 34
Test equipment

The automatic test equipments (ATE) shown here are from the Elliott Seven Seventy Series, the latest of the automatic check-out and test systems which the Automatic Test Equipment Division has now been designing and producing for well over ten years. The Seven Seventy Series of ATE is suitable for testing military, naval and airborne equipment. Installation can be static or mobile, as shown here. Brief technical details are shown overleaf.

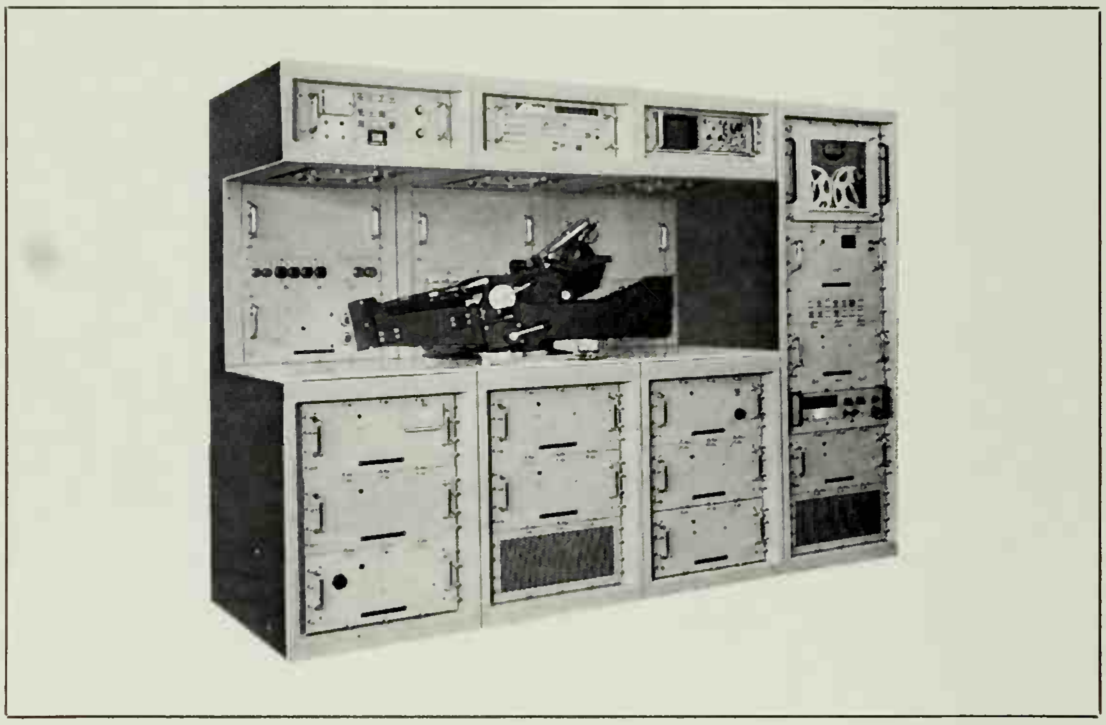
Air Force application

A current example of the Seven Seventy Series of equipment designed for depot and workshop use is the Nimrod multi-system ATE shown here. It is being supplied to the RAF for testing LF instruments and control systems at second line servicing level



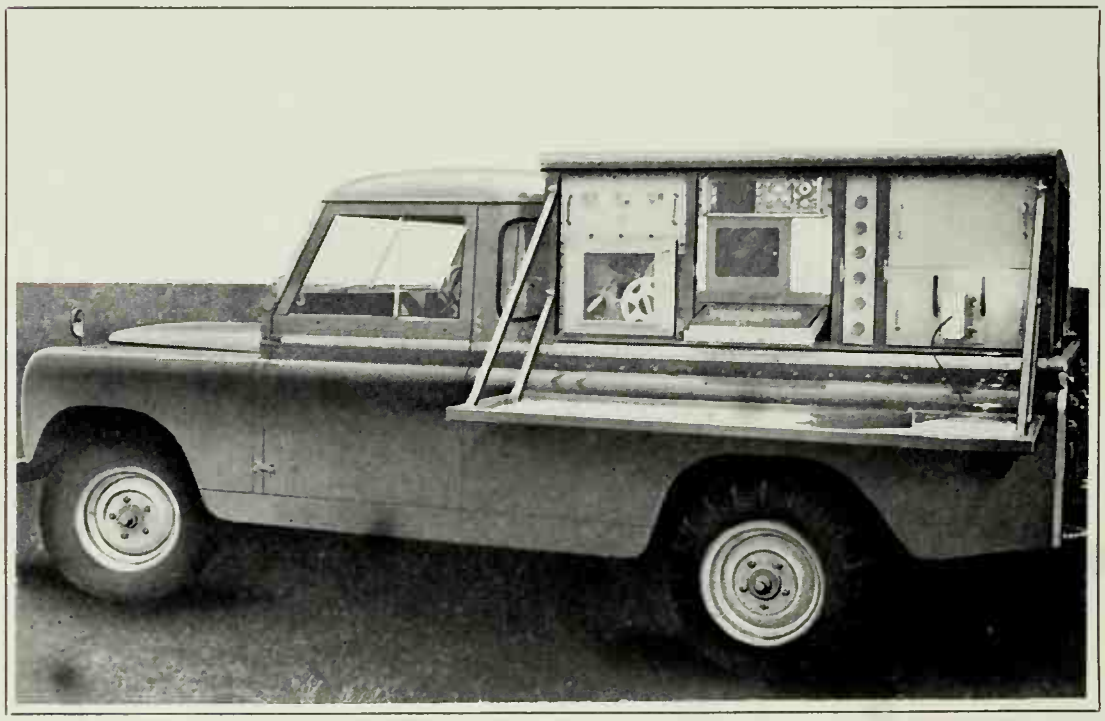
Navy application

The equipment illustrated is one of the ATEs supplied to the United States Navy and United States Air Force in quantity for use at field and intermediate level on a system of the A7D/E Corsair II aircraft. These are single-system automatic test equipments which also serve as repair benches



Army application

Mobile test stations such as the one illustrated are the latest addition to the Seven Seventy Series and comply with the British Army General Staff Requirement for a multi-system highly mobile automatic test equipment



Automatic test equipment

for military and industrial use

Depot and workshop-type ATE
Both single-system and multi-system ATEs are used in depots and workshops depending on the throughput and other operating and economic factors.

A current example of this type of equipment is the Nimrod multi-system ATE shown at the left.

A more restricted example is Factory Automatic Test Equipment (FATE) used in the production testing of a single electronic system and its cards and modules. This type of equipment is highly cost-effective where the throughput is large and/or complex.

Field-type ATE
Equipments of this type are single-system test equipments which also serve as repair benches.

They are built to MIL Specifications to meet a field or shipborne environment, are air-transportable and represent a highly cost-effective type of system test and repair facility.

By restricting the capability to a single system they can be designed, built and introduced more rapidly than multi-system equipments and are representative of the latest trend in military aircraft testing.

Mobile-type ATE
A testing capability from dc to microwave has been achieved with a reduced quantity of hardware by making increased use of the powerful computing facility included in the equipment.

The equipment can withstand a severe environment, is highly mobile and represents a major breakthrough in 'battle-field' testing and maintenance of electronic equipment.

Equipment of this type can also be used dismounted in a screened shelter or be installed in a larger electronics repair vehicle to provide improved operating conditions.

Automatic Test Equipment (ATE) is equipment which carries out a series of tests rapidly and automatically in accordance with a predetermined test program.

ATE is mainly used to test electronic systems and equipment during the production and in-service phases. Using suitable transducers, other types of equipment (such as electromechanical, optical, pneumatic and combinations of these with electronics) can also be tested.

ATE is particularly cost-effective when used for the rapid testing of complex equipment, or large numbers of the same or similar equipments, also where a shortage of skilled manpower exists. With ATE only a small number of skilled engineers is required to prepare the test programs—the ATE operator need only be semi-skilled.

The main advantages of ATE are its speed and integrity of operation, so that the introduction of ATE results in:

reduced testing time,
reduced skilled manpower requirements,
increased efficiency and decreased cost of test and repair,
confidence levels established quickly and accurately,
money saved through above actions.

However, the introduction of ATE involves much more than the selection of suitable equipment. It is a complex activity since the design of the ATE and its economic operation are influenced by many external factors presenting an involved management problem. Consequently a high degree of co-operation between customer and vendor is required to provide the most cost-effective operational and technical solution.

The Elliott Automatic Test Equipment Division has been producing ATEs for over a decade, during which period the Division has developed a series of automatic check-out and test systems for a variety of applications. The Elliott Seven Seventy Series represents the current range of ATEs designed for use by the armed services and industry.

General
The equipment illustrated overleaf is a general-purpose VHF/UHF communications test system.

A simple extension enables this equipment to test ILS/VOR and other navigational equipment.

Many special capability ATEs can be assembled from the range of units in the Seven Seventy Series to test all forms of electronic equipment (including radio-frequency equipment), pneumatic equipment, optical equipment and electromechanical equipment.

Radio-frequency and special ATEs are designed to meet conditions found in depots, workshops, field and mobile use.

A member of GEC Marconi Electronics Ltd
ELLIOTT FLIGHT AUTOMATION LIMITED
Automatic Test Equipment Division
Rochester, Kent, England
Telephone: Medway 44400 Cables: Elliotauto Rochester Telex: 96333

ELLIOTT

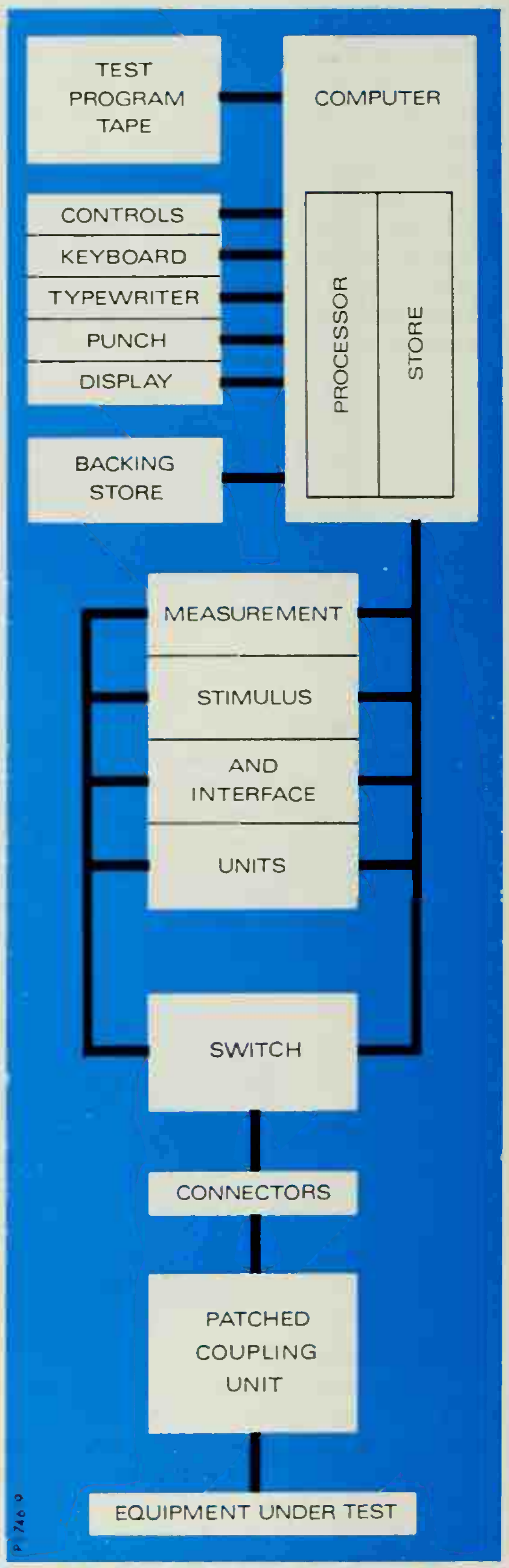
1968
1969
1970

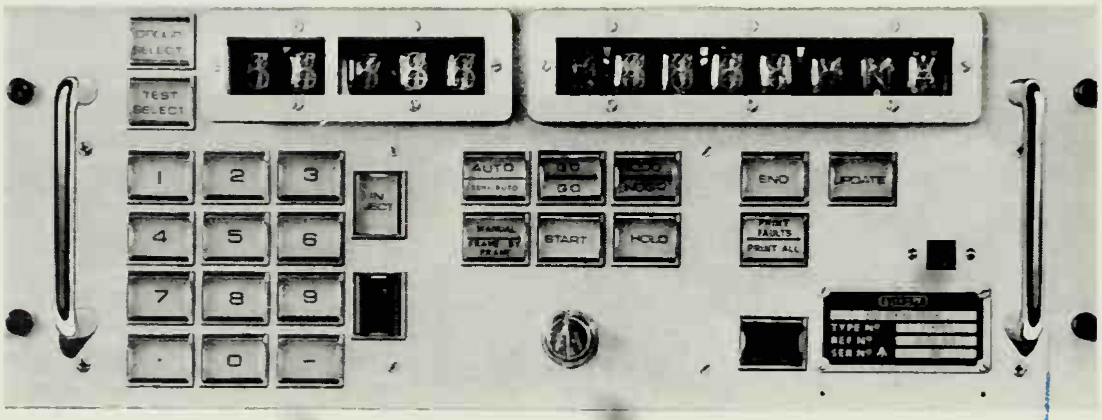
The Seven Seventy Series ATE is suitable for checking out land, sea and air equipment and systems of all types. Typical applications for use in workshops, depots, in the field and of the mobile type are described on the previous two pages. The following are the leading features of the Seven Seventy Series:

Features

All Seven Seventy Series ATEs include:

A general-purpose digital computer.	A computer appropriate to the application is selected from the Marconi-Elliott range; however, a computer outside this range can be used if this is desirable for logistic or other reasons.
A wide measurement and stimulus capability to the level of accuracy required.	Use of the computer enables a wide test capability of the required accuracy and calibrated at the interface to the tester to be provided with the minimum of hardware.
A range of input, output and control arrangements consistent with the test (or test and repair) application and level of operator skill.	Controls are simple and ergonomically designed. Input is by keyboard or typewriter and output by display, typewriter, line printer or punch-out for computer analysis. Numicators, cathode-ray-tube or solid-state displays with full alphanumeric presentation, or film display assist the operator.
A connection system applicable to the equipment(s) under test (EUT).	Reliable switching (relay and solid-state) and patched coupling units provide an economic EUT interface, appropriate to the present and future test function.
A design to withstand the environment encountered in service.	Testers are designed for field or mobile roles in accordance with US MIL Spec. 21200D and British Defence Spec. 133, or for normal workshops use.
A self-check, self-test and calibration facility.	These automatic facilities are provided at various levels to enable the customer's maintainability requirements to be met.
A design to facilitate extension or modification of application.	The system concept is flexible and permits changes and additions in the application of the ATE to be made economically with minimum disruption.





Typical control and display unit

Alpha-numeric and film display unit

Automatic test equipment

The Seven Seventy Series

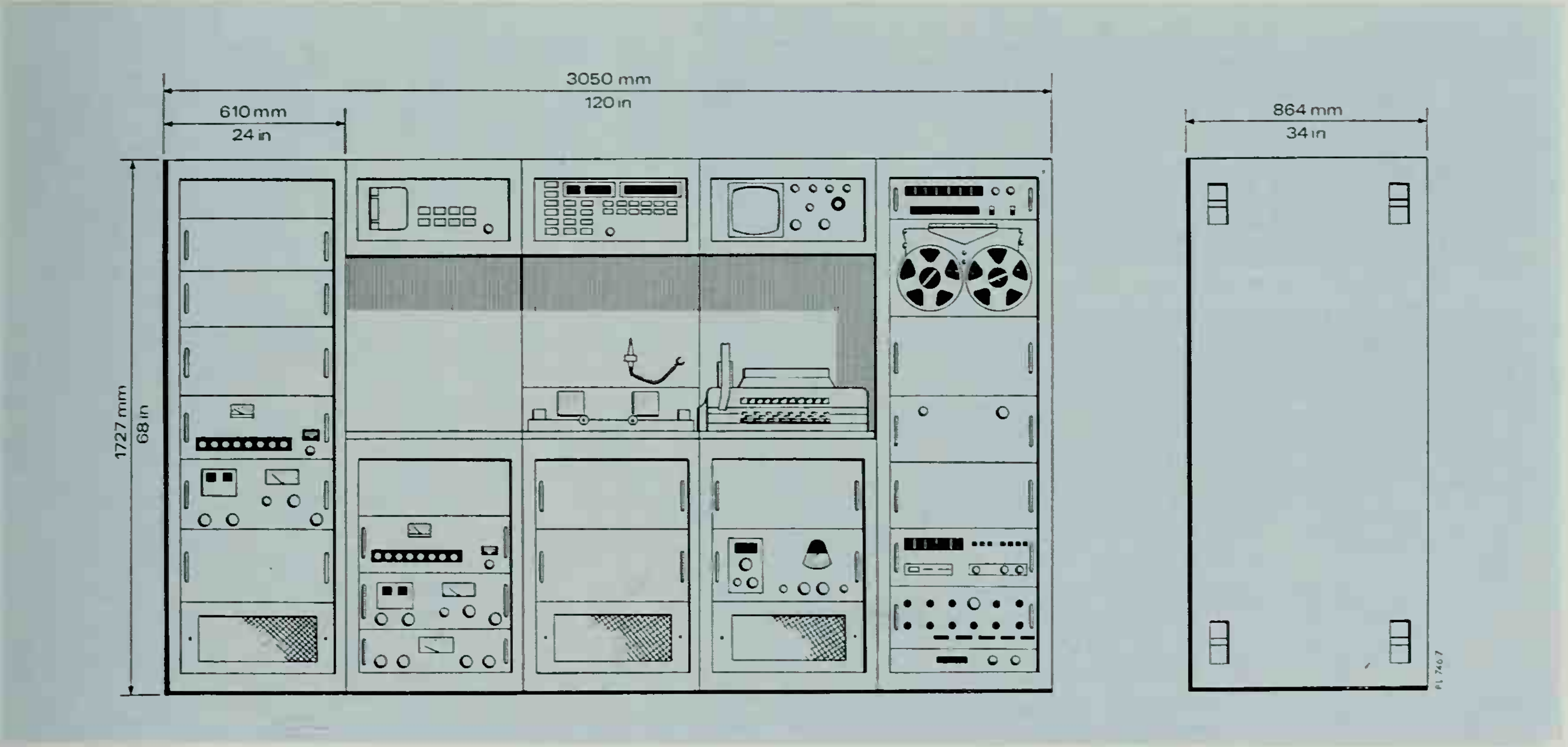
System capability
The various possible versions of the Seven Seventy Series of automatic test equipment (ATE) are capable of testing electronic equipment operating in the frequency range from dc to microwave. They are also capable of testing digital, pneumatic, electromechanical and optical systems and combinations of these with electronics.

The depth of testing inherent in the system ranges from 'Go/No Go' to full diagnostic.

The testing capability and accuracy provided in any one ATE is dependent on many factors but especially on the measurement and stimulus facilities incorporated. The Seven Seventy Series includes a wide range of fully developed stimuli and measurement units of different levels of accuracy.

Increased use of the computer with appropriate software programs to modify a basic stimulus unit, or to determine the accuracy and range of measurement, enables the measurement and stimulus requirements to be exactly met with the minimum of hardware. This reduction in hardware is leading to equipment getting smaller, costing less, becoming more reliable and easier to modify or extend, as the latter usually only requires minor software revision or addition.

The Seven Seventy Series is taking full advantage of these new techniques as they are developed.



General-purpose UHF/VHF/HF communications equipment ATE

Management capability
The design of any automatic test equipment is dependent on many technical, operational and economic factors. To obtain a cost-effective solution a balance must be struck between capital cost and the cost of introduction, maintenance and possible future extension.

The choice of whether to use multi-system or single-system testing, what computer to use, what operator/test station interface and what interface between test station and equipment under test to provide, all require detailed consideration in relation to the application and associated operational requirements.

The Automatic Test Equipment Division of Elliott Flight Automation Ltd, as experienced system managers on many forms of automation, are well qualified to advise on these aspects. The Seven Seventy Series includes suitable hardware to implement recommendations made, and appropriate software is provided, preferably in association with the customer.

The following information is required to enable basic proposals to be prepared:

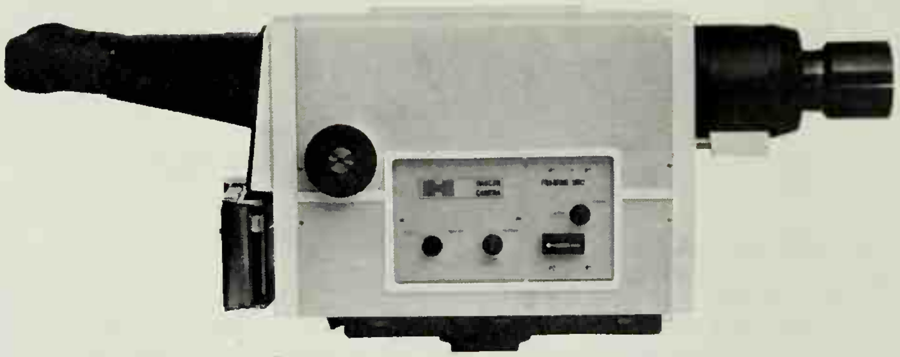
Fullest details of equipment to be tested
Environmental, operational and administrative conditions
Quantities involved and rate of throughput
Present method of test (if any)
Extent of intended local participation
Anticipated expenditure on purchase and introduction of ATE.

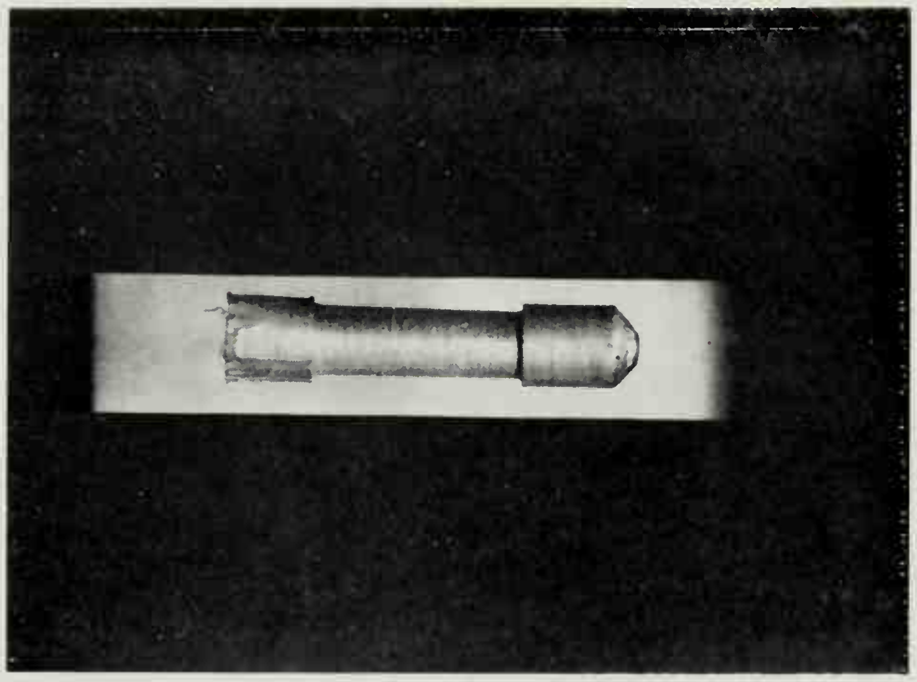
A member of GEC Marconi Electronics Ltd
ELLIOTT FLIGHT AUTOMATION LIMITED
Automatic Test Equipment Division
Rochester, Kent, England
Telephone: Medway 44400 Cables: Elliotauto Rochester Telex: 96333

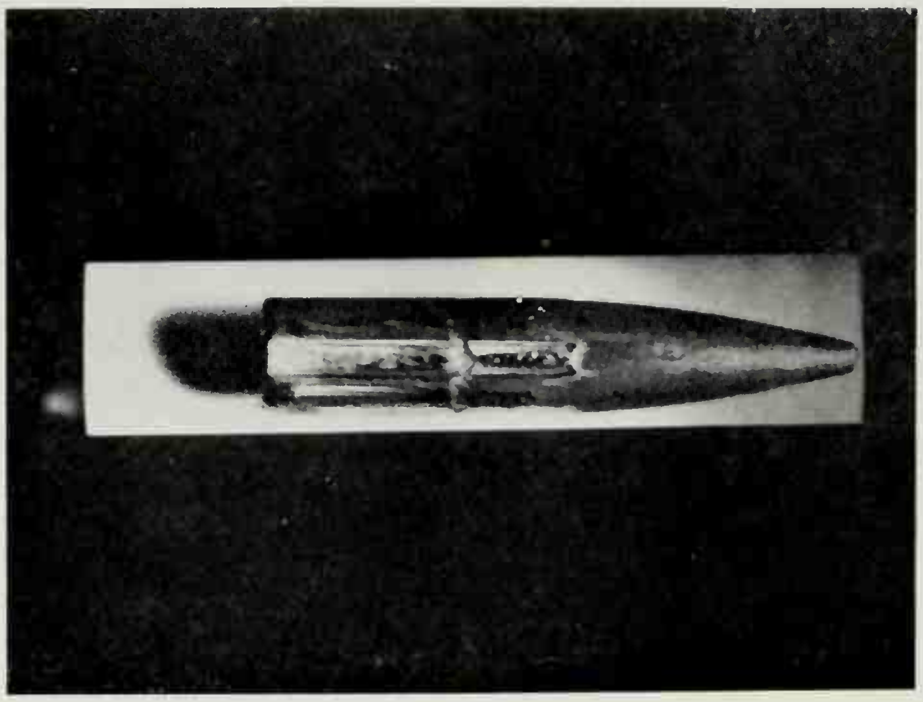
ELLIOTT

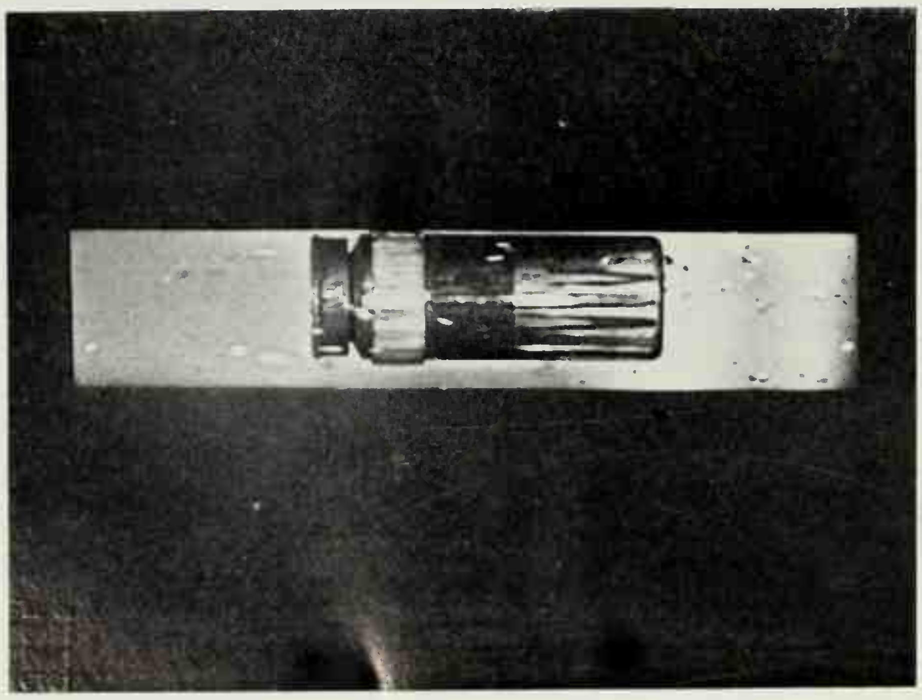
1968
1969
1970

Right: the Imacon ultra-high-speed camera is a compact self-contained unit ideally suited for the recording of high-speed events in general and of projectile performance in particular







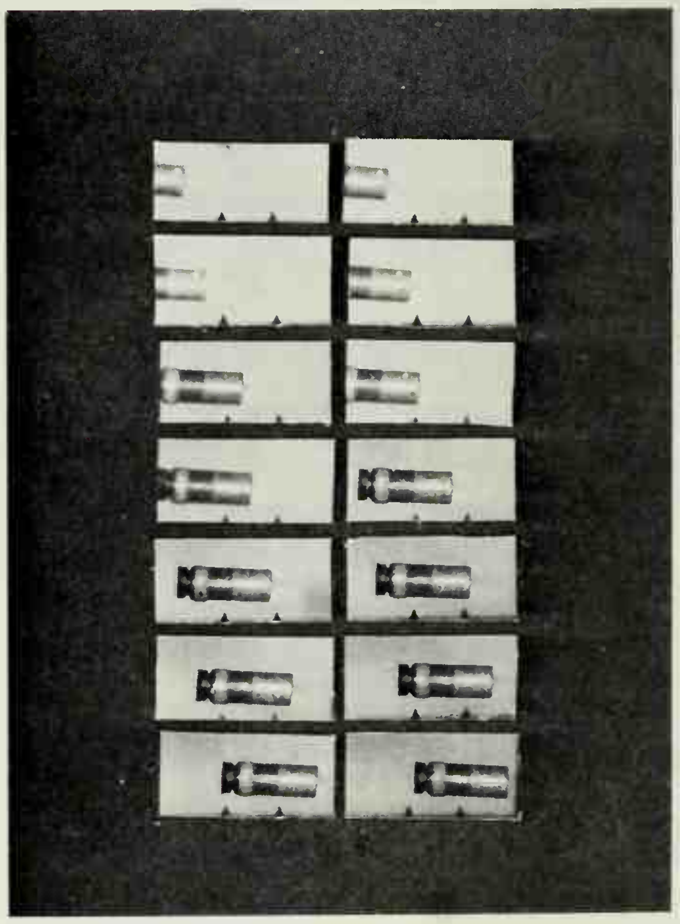


Left top: Ballistic-synchro record of ·22 calibre round 150 mm from muzzle of rifle. Velocity is 311 m/sec (1030 ft/sec)

Left centre: Ballistic-synchro record of ·303 calibre round, taken 1 m from muzzle of SLE rifle. The record shows projectile velocity to be 552·9 m/sec (1814 ft/sec)

Left bottom: Ballistic-synchro record of 30 × 84·9 mm shot, taken 10 m from muzzle. Shot velocity is 1061·6 m/sec (3483 ft/sec)

Below: framing mode record of 0 × 84·9 mm shot, showing the shot to have a velocity of 1061·0 m/sec (3481 ft/sec). Taken at Imacon framing speed of 1 × 10^5 images/sec



Ultra-high-speed camera

for projectile and explosives research

Imacon is an ultra-high-speed camera specially designed for photographic examination of the active behaviour of projectiles and explosives. It may be used to take sequences of individual 'framing' pictures or large single pictures by the 'streak' or 'ballistic-synchro' methods.

Advantages

Imacon is an electro-optical device that does not use cine film and has no moving mechanical or optical components. It therefore has a high degree of reliability and freedom from wear and breakdown. Each photographic record is made on a single Polaroid print, running costs are less than one per cent of the costs of film camera methods and results are accessible only 10 seconds after firing.

The ballistic-synchro photographic technique is an elegant means of acquiring data of in-flight appearance of artillery, rocket and small arms projectiles. Indeed, it is the only practical method of high-definition reflected-light photography of rounds in flight. Clear evidence is given of gun barrel damage, shown by related markings on the surface of the round. Also, simultaneous measurement of all relevant parameters of interest, such as velocity, spin and flight angle can be made by this method. Before the Imacon camera became available, ballistic-synchro technique had been confined to studies of relatively large-calibre ammunition because of the limitations of the 16 mm or 35 mm high-speed cine cameras which had to be employed. The use of such cameras also required provision of attendant film processing facilities, additional personnel and long delays while the films were processed. The long lengths of film required were expensive.

The Imacon camera overcomes all these disadvantages. In the framing mode of operation it provides the most advanced possible means of studying projectile impact and penetration phenomena, fragmentation, explosive detonations and other related subjects, all with the one instrument. The framing mode results in a sequence of separate images recorded on one sheet of film at rates of up to twenty million per second. The ballistic-synchro mode produces one large single picture. To change from one mode to another merely involves interchanging simple low-cost plug-in modules.

Operation

Basically, the system converts an image formed by a conventional lens into an electron beam image, which, on striking a phosphor screen, recreates a light image that can then be recorded on film. During the electron beam phase the image can be electronically shuttered at very fast rates or streaked across the phosphor screen at any desired speed.

The latter method is used for ballistic-synchro recording, where the beam is swept across the screen at a speed proportional to that of the projectile. The field of view of the camera is deliberately restricted so that, at any one moment in time, it sees only a thin vertical line across the projectile, perpendicular to its line of flight. The photograph of the complete length of the projectile is recorded as it passes across this line. Thus, the image of the nose is recorded before the image of the base, the time difference being that taken by the projectile to pass through its own length. Direct measurement along the pre-calibrated time axis enables velocity measurements to be made to a high degree of accuracy; means are provided for easy re-calibration checks. Gun barrel damage can be determined by the nature of the marks on the projectile and spin rate by the angle of the markings as they appear on the photograph; pitch and yaw are also readily measured.

Experience on British and other ranges confirms the extraordinary usefulness and versatility of this instrument and the remarkable savings in range time and cost made possible by its use.

Specification

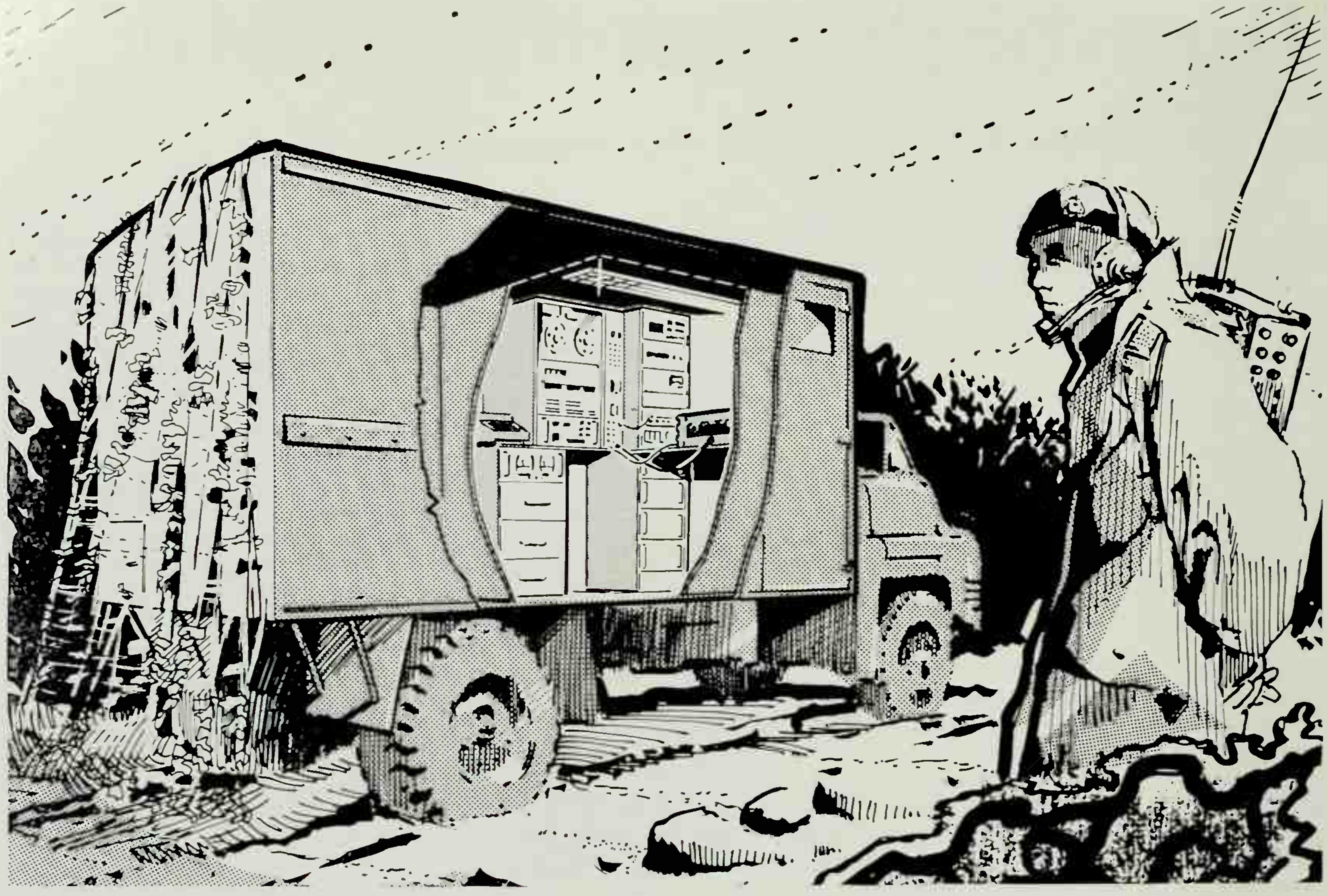
Dimensions
Length: 980 mm
Width: 254 mm
Height: 380 mm
Weight: 27 kg

Electrical
Power supply: 110 or 250 V ac, 50–60 Hz
Consumption: 50 W

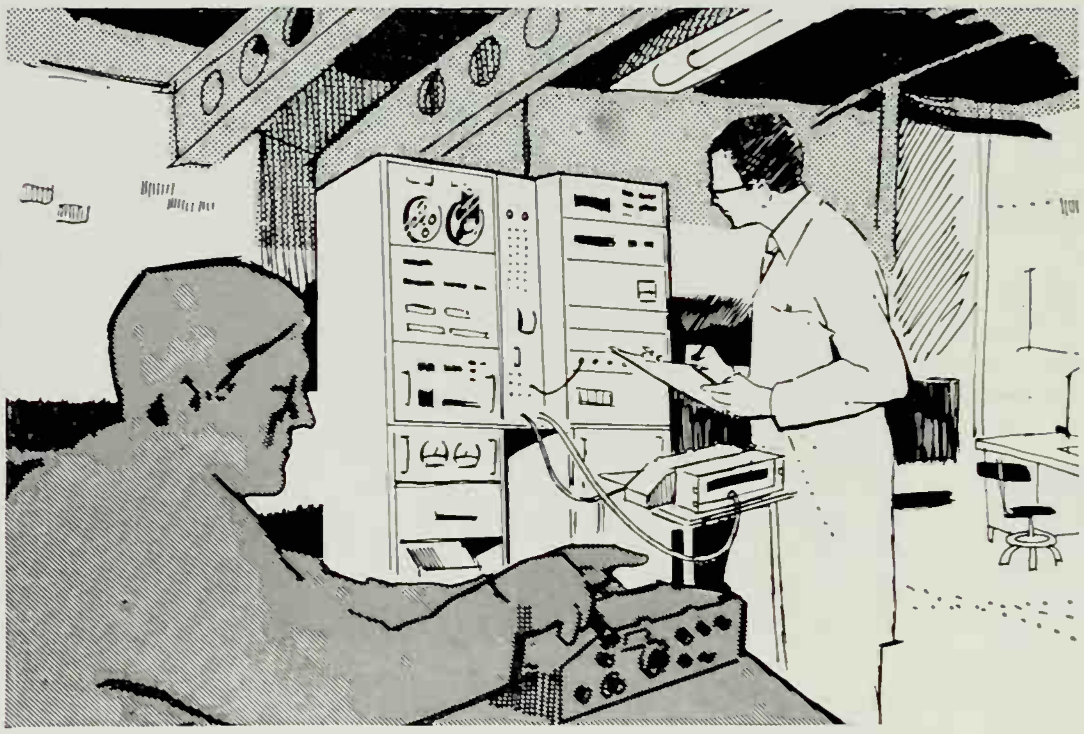
Ballistic-synchro mode
Picture size: 70 × 18 mm
Velocity adjustment: by ten-turn potentiometer with three-decade digital dial, to match any projectile velocity and calibre
Lens focal length: 18–560 mm, longer focal lengths to special order

Framing mode
Speeds: from 1×10^4 to 2×10^7 images per second, variable by interchanging low-cost plug-in modules
Number of images per picture: variable from 6 to 20 by preset and panel controls
Image size: 8 images 15 × 15 mm
10 images 15 × 10 mm
14 images 15 × 6 mm
16 images 15 × 6 mm
20 images 15 × 5 mm
Trigger input: typically 25 V positive into 50 ohms
Camera backs: for Polaroid roll film and sheet film or for conventional negative materials

JOHN HADLAND (Photographic Instrumentation) LTD
Newhouse Laboratories, Bovingdon, Hertfordshire, England
Telephone: Hemel Hempstead 2303. Cables: Johhadland London Telex: 82344



Field test console, mobile installation



Field test console, workshop installation

The field test console can check a radio equipment by using a programmed test sequence; some of the tests available are:

1 Voltage measurements
2 Current measurements
3 Transmitter radiated frequency and frequency accuracy
4 Transmitter modulation sensitivity
5 Transmitter modulation response
6 Transmitter RF power output
7 Transmit/receive delay
8 AF sidetone while transmitting
9 Transmitter intermodulation products on SSB mode
10 Transmitter squelch tone
11 Receiver signal-to-noise ratio
12 Receiver AF output power
13 Receiver limiting on FM
14 Receiver AGC
15 Receiver bandwidth

One of the electro-mechanical interfaces used with the test console

Field test console

for Clansman radio communications system

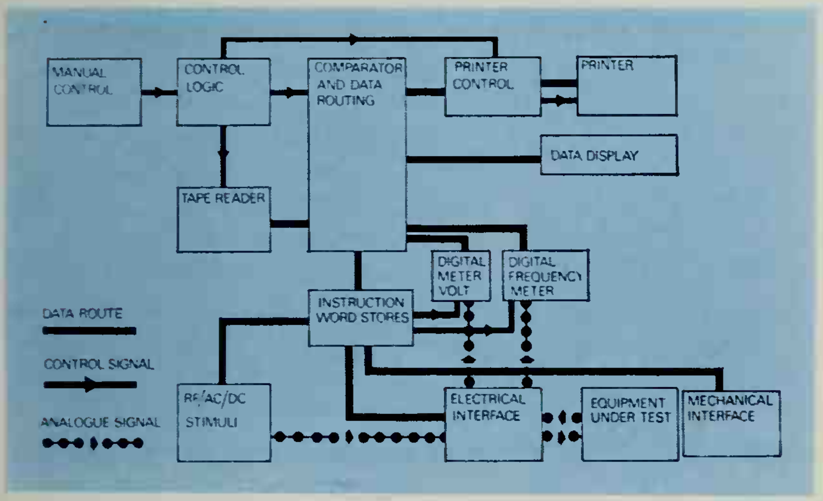
The family of six radio sets in the Clansman system is replacing at least twenty-four separate equipments now in use with infantry, armoured vehicles, gun and missile batteries, ground-to-air links, beach landing and parachute troops.

The quick and reliable testing in the field of all its units was part of the design concept of the Clansman system. The Clansman field test console, designed to meet the stringent specifications of the British Ministry of Defence, is capable of testing and diagnosing faults in the whole range of Clansman radio equipment.

The test console has been chosen by the British Army to support their Clansman equipment both in the field and at base. It is normally installed in the screened test enclosure which forms part of a mobile electrical repair vehicle. However, it could be used in any location as no highly specialised facilities are required.

The equipment is completely automatic and is operated by pre-punched 8-hole tape; it comprises a central control section and a number of peripheral units. These units, which supply stimuli and measurement facilities, are carefully selected test instruments. They may be used manually for diagnosis, either installed or removed from the test console. The system has been so designed that modifications and technological innovations may be added in the future. The test procedures are programmed on the tapes which accompany the console and ensure very rapid testing with the minimum of operator skill or knowledge. This reduces operator error and clearly gives an indication of a Go or No-Go status of the set being tested. All test results can be printed out, enabling trend analysis of radio component failures to be made. Modifications to the sets, or changes in operator usage instructions, can be made authoritatively from such information.

While under test the radio is coupled to the console through an electro-mechanical interface which provides the required electrical connections and the correct mechanical operation of the radio controls. A specially designed interface is provided for each type of radio in the Clansman series. During testing it is coupled to the radio and it automatically selects the required knob positions on the radio for any particular test. This function is carried out at high speed, cutting the test time to a minimum.



Basic block diagram of the Clansman field test console. The control system is crystal-clocked TTL logic, employs a 16-bit instruction word, with a maximum word rate of 15 per second. Full manual control of the machine can be selected at any time

Specification

1 Voltage measurements
AC and dc 4-digit plus over-range display
Voltage range: 0–1000 V in 6 ranges
Frequency range: 30 Hz to 150 kHz
Sensitivity: 1 µVdc, 10 µVac

2 Current measurements

3 Transmitter radiated frequency and frequency accuracy
Frequency range: 10 Hz to 120 MHz extendable to 500 MHz
8-digit resolution
50 mV sensitivity
Stability ±2 parts in 10^9

4 Transmitter modulation sensitivity
AM/FM capability
Modulating signal range: 0–8 V emf

5 Transmitter modulation response
Modulation frequency, range: 0–100 kHz

6 Transmitter RF power output
Power range: 100 mW to 100 W, for frequencies up to 500 MHz

7 Transmit/receive delay
Range: 100 ms to 100 s

8 AF sidetone while transmitting
Frequency range: 30 Hz to 50 kHz
AF signal sensitivity: 10µV rms

9 Transmitter intermodulation products on SSB
Selective measurements over the range 1–120 MHz
Sensitivity: 10 mVfsd
Dynamic range: 70 dB

10 Transmitter squelch tone
Frequency range from 10 Hz with measurement stability ±2 parts in 10^9

11 Receiver signal-to-noise ratio
Up to 100 dB signal plus noise /noise

12 Receiver AF output power
Range 100 µW to 25 W, 10 Hz to 50 kHz

13 Receiver limiting on FM
AF measurement to ± 0·1% accuracy

14 receiver AGC
AF measurement to ±0·1% accuracy

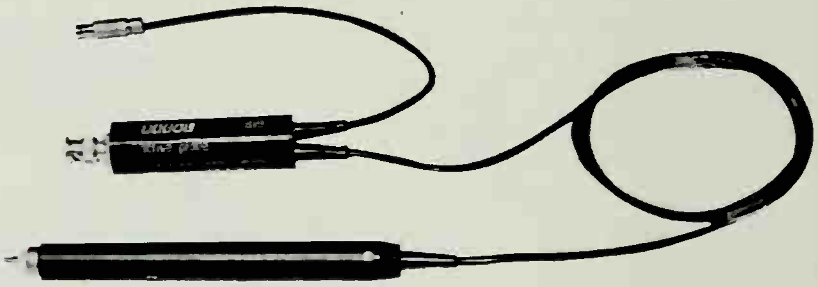
15 Receiver bandwidth
Accurate broad and narrow-band selectivity measurements

HONEYWELL LIMITED
Test Systems Division
Eaton Road, Hemel Hempstead, Hertfordshire, England
Telephone: Hemel Hempstead 2141 Cables: Honeywell Hemel Hempstead
Telex: 82165

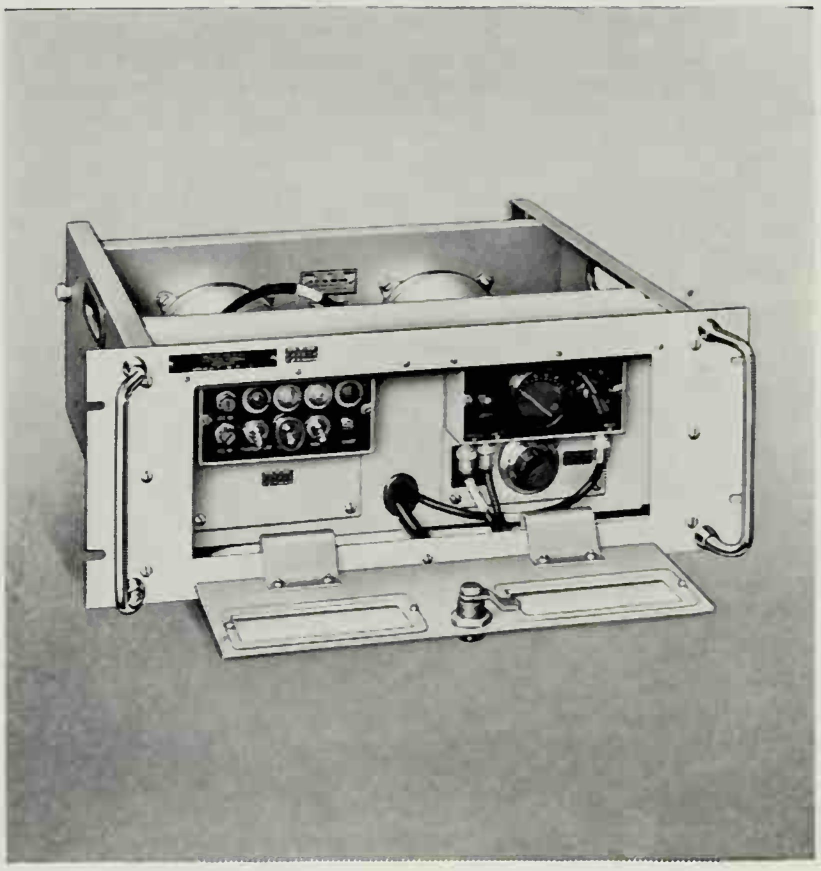
Honeywell

1969

Left: This robust digital frequency meter has been chosen for use in an automatic test equipment role in the 'Clansman' communications systems, and is eminently suited as a standard military test instrument for use between 10 Hz and 125 MHz, extendable to 500 MHz using the type 802 M frequency converter. The latched eight-digit display has a transfer time of only 25 msec allowing 25 Hz flutter to be indicated



Above: The active probe Type 819 increases the signal sensitivity of the 801 M digital frequency meter to 1 mV over the frequency range from 10 Hz to 125 MHz. All-solid-state. Power obtained from 801 M meter. Input impedance 1 Megohm in parallel with 5·6 pF.



The Racal MA259G precision frequency standard is stable to within 5 in 10^{10} per day. Ruggedly designed for military use, it has three outputs at 1MHz, 5MHz, and 100kHz. There is automatic changeover to the internal battery supply in the event of mains failure

Airmec
MODULATION METER TYPE 409

This modulation meter made by the Airmec Division has a comprehensive AM and FM specification, and is suitable for both laboratory and workshop use in Service environments. The built-in FM calibrator eliminates the need for external sources of standard deviation when calibrating. The wide frequency range and modulation range make this a versatile instrument, and accuracy is fully up to the requirements of military users

Test instruments

for communications equipment

801M digital frequency meter (NATO Code 6625-99-199-7709)

This 125 MHz directly gated digital frequency meter has been specifically designed for use in an automatic test equipment role in a military environment, being fully remotely programmable, robustly constructed, and having an environmental performance complying with Category 3 of DEF 133. An overspill indicator lamp is fitted, to supplement the eight-digit numerical display, and the input sensitivity of 10 mV can be increased to 1 mV using the type 819 active probe, which is an optional extra. This instrument provides a resolution of 1 Hz in 1 second, and the inbuilt frequency standard has a stability of better than 2 parts in 10^9 per day. A four-line 1-2-4-8 binary-coded decimal output is provided as a standard feature.

Specification

Frequency range: 10 Hz to 125 MHz
Input sensitivity: 10 mV (1 mV with Type 819 probe) impedance 1 megohm/15 pF. With active probe Type 819 sensitivity increased to 1 mV over entire frequency range
Timebase stability: better than 2 in 10^9/day, 3 in 10^9 for 6% supply variation 5 in 10^{10}/1°C
Display: 8-digit inline, display time equals gate-time approximately, transfer time 25 msec. Overspill panel lamp fitted
Self-check facility: operates all circuits except pre-amplifier
Dimensions: 127 × 438 × 466 mm ($5\frac{3}{4}$ × $17\frac{1}{4}$ × $19\frac{3}{4}$ in)
Weight: 12·8 kg (28·5 lb)
Categorised in Common Range Electrical Test Equipment List as CT 574/3

MA259G precision frequency standard (NATO Code 5820-99-948-8560)

The MA 259G meets the demands for higher accuracy and reliability of frequency stability in complex communications systems, satellite tracking and navigation applications, in calibration centres and standards laboratories. It withstands the stringent environmental conditions of military applications in semi-mobile use. Day-to-day stability is better than 5 parts in 10^{10}, and performance is almost unaffected by normal changes in ambient temperature, power supply, or loading conditions. A power unit and a re-chargeable battery supply are included. If the mains supplies fail, automatic changeover to battery supply occurs, maintaining operation for ten hours. All semi-conductors are silicon, and fail-safe frequency dividers are a feature of the design, providing optimum reliability. It is a standard unit in the Royal Navy.

Specification

Output frequencies: 5 MHz, 1 MHz, 100 kHz
Output level: 1 V rms into 50 Ω
Frequency stability:
    24 h 5 in 10^{10}
    1·0 sec 4 in 10^{10} rms
    Load (changed 20%) 2 in 10^{11}
    Input (changed 20%) 2 in 10^{10}
    Ambient temp. changed ±35°C from 25°C 5 in 10^{10}
Power supplies: 105/125/230 V ac 48/400 Hz
Dimensions: 180 × 483 × 438 mm (7 × 19 × 17 in)
Weight: 9 kg (20 lb) approx. complete

AM/FM modulation meter type 409 (Nato Code 6625-99-199-3370)

This economically priced modulation meter provides AM and FM measurement from 3 to 1500 MHz, AM measurement from 0–100 percent and FM measurement from 0 to 600 kHz. Three AM ranges with full-scale deflections of 0, 30, and 100 percent ensure high accuracy of measurement, even at low modulation levels. There is a built-in switchable noise filter, especially for narrow-deviation FM. The calibrator circuit incorporated for FM, high sensitivity, simple operating procedures and robust design make this instrument ideal for workshop use.

Specification

Frequency range: 3–1500 MHz
Sensitivity: from 7 mV to 100 mV, 3 MHz to 1200 MHz
FM measurement: deviation 0–600 kHz in 6 ranges
Inherent noise: noise filter 'in', deviation due to noise 46 dB below 3 kHz, over 300 Hz to 3 kHz
AM measurement: 0% to 100% in 3 ranges, 3 to 1200 MHz
Mean carrier: changes in level measured with accuracy 1%
Maximum input: 10 V FM, 700 mV AM
Accuracy: FM 5% fsd 10 Hz to 50 kHz deviation. AM 3% fsd, 30 Hz to 5 kHz, 5% fsd to 20 kHz
Monitor outputs: LF 10 Hz to 50 kHz and IF 1 MHz available on front panel
Power supplies: 100–250 V 50 to 60 Hz, 120 VA
Dimensions: 431 × 321 × 279 mm (17 × $12\frac{5}{8}$ × 11 in)
Weight: 14 kg (31 lb) approximately

RACAL INSTRUMENTS LIMITED
Duke Street, Windsor, Berkshire, England
Telephone: Windsor 69811 Cables: Racal Windsor Telex: 847013

RACAL

SOLARTRON
+ 2.2 9 9

Type LM 1420.2BM (CT 469) dc plus wide-band mean ac sensing digital voltmeter

Type LM 1604 dual ramp integrating dc digital voltmeter with plug-in ac capability

SOLARTRON
.9 9 9 9 9
SOLARTRON

Type LM 1867 precision dc digital voltmeter

SOLARTRON DIGITAL T.F.A. JM 1600
CORRELATOR
GENERATOR
SOLARTRON

Type JM 1600 digital transfer function analyser

SOLARTRON MECHANICAL REFERENCE SYNCHRONISER JX1606

Type JX 1606 mechanical reference synchroniser for use with the type JM 1600 digital transfer function analyser

SOLARTRON
SOLARTRON
+ 1 4 1 4

Type JM 1860/1861 digital LF correlator, comprising type JM 1861 pseudo random binary sequence generator and type JM 1860 time domain analyser

Digital instruments

for voltage measurement and dynamic analysis

Type LM 1420.2BM voltmeter (CT 469)

AC measuring facilities are provided by two ac/dc versions of the basic Solartron type LM 1420.2 digital voltmeter. Type LM 1420.2BA provides dc, true rms and mean ac measurement, while type LM 1420.2BM is a higher accuracy wide-band mean ac sensing version providing ac and dc measurement facilities at only a small increase in cost over the basic instrument.

Specification

Facilities: dc and mean ac sensing
Input: isolated on ac and dc
Accuracy: ±0.05% dc, 0.1% ac
Frequency ranges: 10Hz to 50kHz
Sensitivity: 2.5μV to 1000V dc, 10μV to 500V ac
Operating temperature: 0 to +50°C
Mounting: bench or 19-in rack type

Type LM 1604 voltmeter

This is a dual-ramp integrating dc digital voltmeter with an ac measurement capability using the type EX1605 plug-in unit. The standard fan-out unit enables the ranges to be selected remotely by three BCD inputs; it also enables the plug-in unit to be controlled when fitted.

Specification

Facilities: dc measurement with ac capability using plug-in unit
Ranges: 19·999mV to 1000V full scale in 6 ranges
Sensitivity: 1μV
Accuracy: ±0·005% of full scale; ±0·005% of reading
Input current: $<10^{-10}$A
Operating temperature: 0 to +50°C
Noise rejection: <1μV error from 500V noise

Type LM 1867 voltmeter

This is a precision dc digital voltmeter using the well-tried potentiometric technique to provide high accuracy, high sensitivity and a fast conversion rate. The instrument is typically suited to standards room, laboratory or production line measurements, or may be incorporated in data handling systems.

Specification

Ranges: 1·00000 to 1000·00V dc full scale in four ranges, with over-ranging to 101 999 digits
Accuracy: ±0·001% of full scale; ±0·003% of reading; ±10μV
Output: available in parallel BCD form with polarity and range information. Increased power from optional plug-in fan-out unit
Operating temperature: +5 to +45°C
Mounting: bench or rack type
BCS certificate available

Type JM 1600 analyser

This is a digital transfer function analyser designed specifically for measuring the dynamic performance and behaviour of systems and components. The use of digital techniques ensures optimum stability, accuracy and resolution of measurement, particularly at low frequencies, and facilitates the incorporation of the equipment into automatic check-out and test systems. The instrument comprises a function generator as a source of excitation to the system under test, and a digital correlator which computes dynamic response for display by an in-line digital read-out.

Specification

Frequency range: 0·00001-159·9Hz
Frequency accuracy: 0·05% of setting
Input: fully floating and isolated from unit under test
Digital display: cartesion, polar or log polar
Remote programming and recording facilities: provided by optional add-on units

Type JX 1606 synchroniser

This instrument is used in conjunction with the digital transfer analyser type JM 1600 (above) to enable measurements of frequency response to be made on units and systems with their own source of excitation. When used with the type JX 1606, the type JM 1600 maintains its full measuring accuracy, harmonic and noise rejection properties and read-out and recording facilities.

Specification

Frequency range: 0·000160–159Hz
Harmonic analysis: 1 to 10
Automatic frequency and place locking: within 2 cycles of external signal
Accuracy: fundamental as for JM 1600, harmonics 2%
Interface: fully floating and isolated
Optional facilities: provision for multi-channel and on-line dynamic behaviour recording and analysis with magnetic tape systems

Type JM 1860/1861 correlator

This is a digital LF correlator comprising two units, a pseudo random binary generator type JM 1861 and a time domain analyser type 1860. They are available separately for individual application; any generator can be operated with any time domain analyser to form a correlator. An optional plug-in filter unit type JX 1862 is available when the wave form from the generator is required to provide a power spectrum with a sharp cut-off at a defined frequency.

Specification
JM 1861
Frequency range: 0·01–1MHz
Clock: crystal controlled or external
Output: ±10V peak adjustable by switch and potentiometer
Delay: up to 999 clock periods, automatic sweep delay, multi-level signals

JM 1860
Bandwidth: 10kHz
Measurement accuracy: ±1% ±0·1% of full-scale deflection
Combination: computes one point at a time
Delay set: manual, automatic sweep or external, by BCD commands; automatic operation of printer and plotter

THE SOLARTRON ELECTRONIC GROUP LIMITED
Farnborough, Hampshire, England
Telephone: Farnborough 44433 Cables: Solartron Farnborough Telex: 85245

Test instruments

for electrical and electronic equipment

Multi-range test set No 1

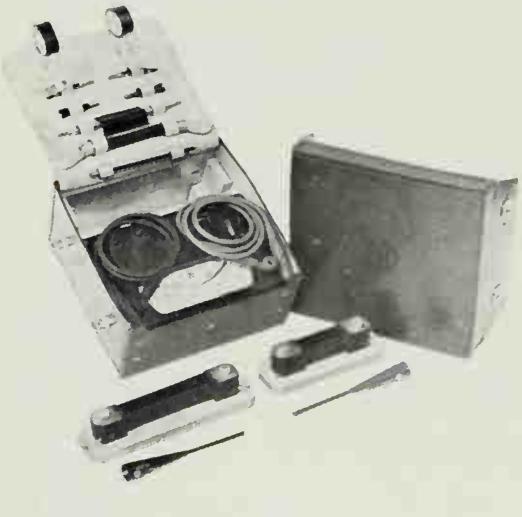
This new Avometer has received approval to British Ministry of Defence Specification DEF. 155.

Specification
Ranges: dc 3 V–3000 V 50 μA–10 A
ac 3 V–3000 V 100 mA–10 A
Resistance: 0-20 megohm
Accuracy: dc voltage and current: ± 1% fsd (except 3 kV)
ac voltage and current: ± 2·25% fsd
Resistance: ± 4% at mid-scale
Sensitivity:
dc ranges: 20 000 ohm/V (50 μA fsd)
ac ranges: 1000 ohm/V (1 mA fsd) on 100 V range upwards
Dimensions: 210 × 190 × 120 mm (8¼ × 7½ × 4¾ in)
Weight: 3·6 kg (8 lb) approx
NATO ref No: 6625–99–105–7049

Avometer Model 12S

This instrument has been designed for testing modern vehicle electrical equipment.

Specification
Ranges: dc 3·6 V–36 V 3·6 A and 36 A
(180 A and 360 A with external shunt)
ac 9 V–360 V resistance 0–10 000 ohm
Accuracy:
dc voltage and dc current: ± 1% fsd
ac voltage (25–2000 Hz): ± 2·25% fsd
Resistance: ± 3% at mid-scale
Sensitivity:
dc voltage range: 200 ohm/V (5 mA fsd)
ac voltage range: 90 ohm/V (11 mA fsd)
Dimensions: 245 × 235 × 114 mm (9⅝ × 9¼ × 5¼ in)
Weight: 3·6 kg (8 lb)
NATO ref No: 6625–99–109–3126



Precision Avometer Mk 2

This self-contained portable precision instrument is an accurate, stable local reference or transfer standard for ac/dc voltage and current measurements.

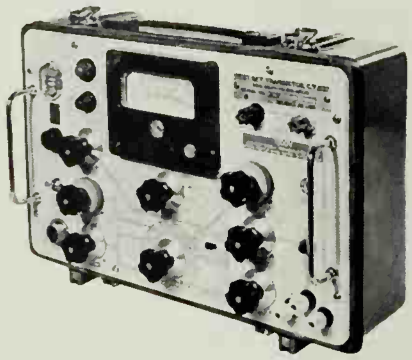
Specification
Ranges: dc 1·5 V–1500 V 1·5 mA–15 A
ac 3 V–1500 V 3 mA–15 A
Accuracy: dc voltage ranges ± 0·3% fsd
dc current ranges ± 0·5% fsd
ac voltage and current ranges:
up to 1 kHz ± 0·75% fsd
Sensitivity:
666·7 ohm/V dc
333 ohm/V ac (75 V up)
Dimensions: 365 × 317 × 196 mm (14⅜ × 12½ × 7¾ in) approx
Weight: 9·9 kg (21 lb 12 oz) approx
NATO ref No: 6625–99–104–5783

Safety test set XT 456

A completely sealed battery-operated instrument. Its primary purpose is testing the firing lines of guided missile systems, to ensure that they are free from voltages which could fire the igniters before the missile is connected to the firing lines.

Specification
Voltage range: 1st indication 10 mV (up to approx 8 kHz)
Resistance range: 0·1 ohm to 10 megohm in four ranges
Input impedance: > 100 kilohm from dc to over 2·5 kHz
Power supply: 2 Mercury safety cells 1·35 V each
Temperature range: Useful operation from −30°C to +70°C
NATO ref No: 6625–99–109–8622

Transistor test set CT 537



The tester provides accurate measurement of transistor and diode characteristics.

Specification
Transistors:
Collector voltage: 0 to 12 V stabilised and continuously variable
Collector current: 0 to 1 A max
Base current: 0·1 μA–50 mA
hfe: 50 to 1500 fsd in 4 ranges
Leakage current I_{CEO}: 10 ranges 0–400 mA max (first indication 1 μA)
Diodes:
Forward volt drop: 5 V and 1·5 V fsd with forward diode current 0–500 mA
Breakdown voltage: 0 to 100 V at 3 mA, 0 to 1000 V at 200 μA
Mains supply: 110, 120, 200, 220 and 240 V ± 6% 50–500 Hz
Dimensions: 38 × 24 × 13 cm (15 × 9·5 × 5 in)
Weight: 9·5 kg (21 lb)
NATO ref No: 6625-99-519-4000

Valve tester CT 160

This instrument can check almost any standard receiving or small transmitting valve.

Specification
Anode voltage: 20 to 400 V in 11 fixed steps
Screen voltage: 20 to 300 V in 11 fixed steps
Grid voltage: 0 to −40 V continuously variable
Heater voltage: 0·625 V to 117 V in two sections
Anode current: 0 to 100 mA
Mutual conductance: 0 to 20 mA/V indicated directly on meter scale
Grid current: 0 to 100 μA
Rectifying valves and signal diodes: Load currents of 1, 5, 15, 30, 60 and 120 mA. The condition of the valve is indicated on a good/replace scale
Mains input: 105–120 V and 175–250 V 50–500 Hz
Dimensions: 390 × 267 × 255 mm (15¼ × 10½ × 10 in)
Weight: 10 kg (22 lb)
NATO ref No: 6625–99–943–2419

AVO LIMITED
Avocet House, Dover, Kent, England
Telephone: Dover 2626 Cables: Avocet Dover Telex: 96283

THORN
A Member of the Thorn Group

Custom-built hydraulics

for equipment and systems testing

Adaptations and originals
There are many situations in which standard hydraulic equipment cannot be adapted to suit special requirements.

Some of the equipment, for example, used in the testing of hydraulic systems and equipment in military vehicles, has itself to be highly mobile. While the simple mounting of static equipment on to a trolley would seem to be an obvious answer, it is not always a simple or a practical proposition.

It is often the same with power packs. A machine designed for permanent, static mounting in concrete, for instance, would present problems if simply transferred to a trolley for the sake of mobility.

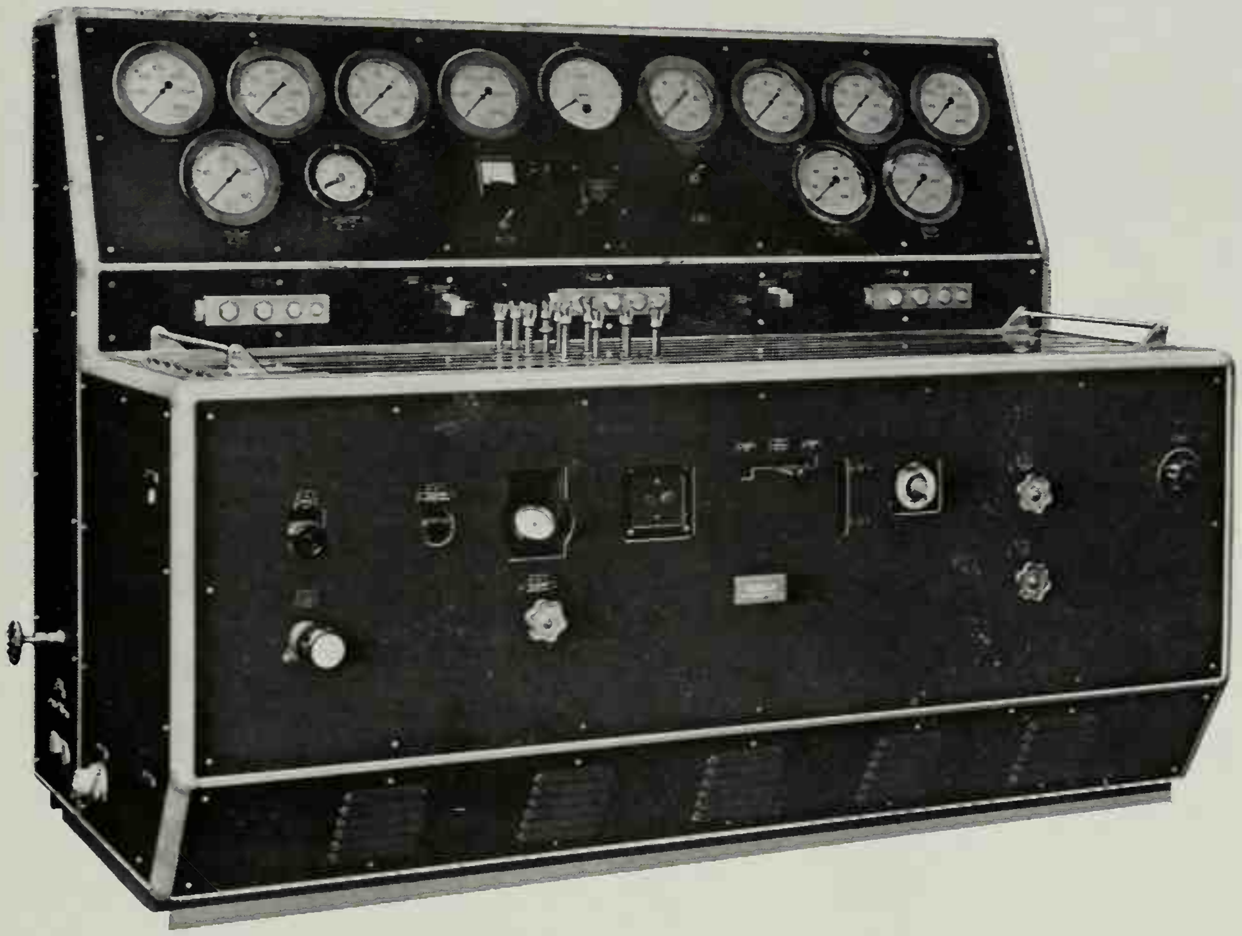
Purpose-built equipment
The practical and sensible answer is to use equipment designed and built specifically for the job in hand.

The HML Engineering Company specialises in hydraulic equipment built to individual specifications. HML produces special equipment for the armed services, the aerospace industry and leading industrial companies.

HML hydraulic test equipment is in current use on the Jaguar tactical support aircraft, and on the Harrier, and in civil aviation on the Concorde, VC10 and 747 Jumbo Jet.

Typical equipment
Among the custom-built hydraulic equipment which may be commissioned from HML Engineering are:

Test rigs, mobile and static, for systems in land vehicles, aircraft, naval vessels and hydraulic installations
Benches for the testing of hydraulic components
Hydraulic ring-main installations and control consoles
Hydraulic ram- and pump-test rigs
Power units for operating storage and other systems
Electrical and hydraulic power packs
Hydraulic converters
High-pressure hydraulic pumping units.



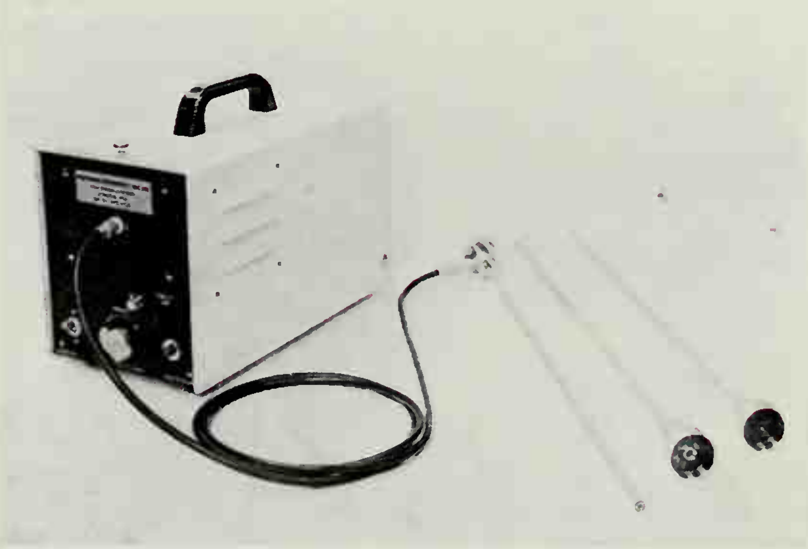
HBE 112 hydraulic test bench with a capacity of 36 litres/min (8 gal/min). This component test bench is a medium-sized, electrically powered unit providing a controlled and filtered supply of fluid from 0 to 350 kg/cm² (0 to 5000 lb/in²)

HML ENGINEERING LIMITED
St John's Road, Isleworth, Middlesex, England
Telephone: 01-560 3011 Telex: 933887

HML

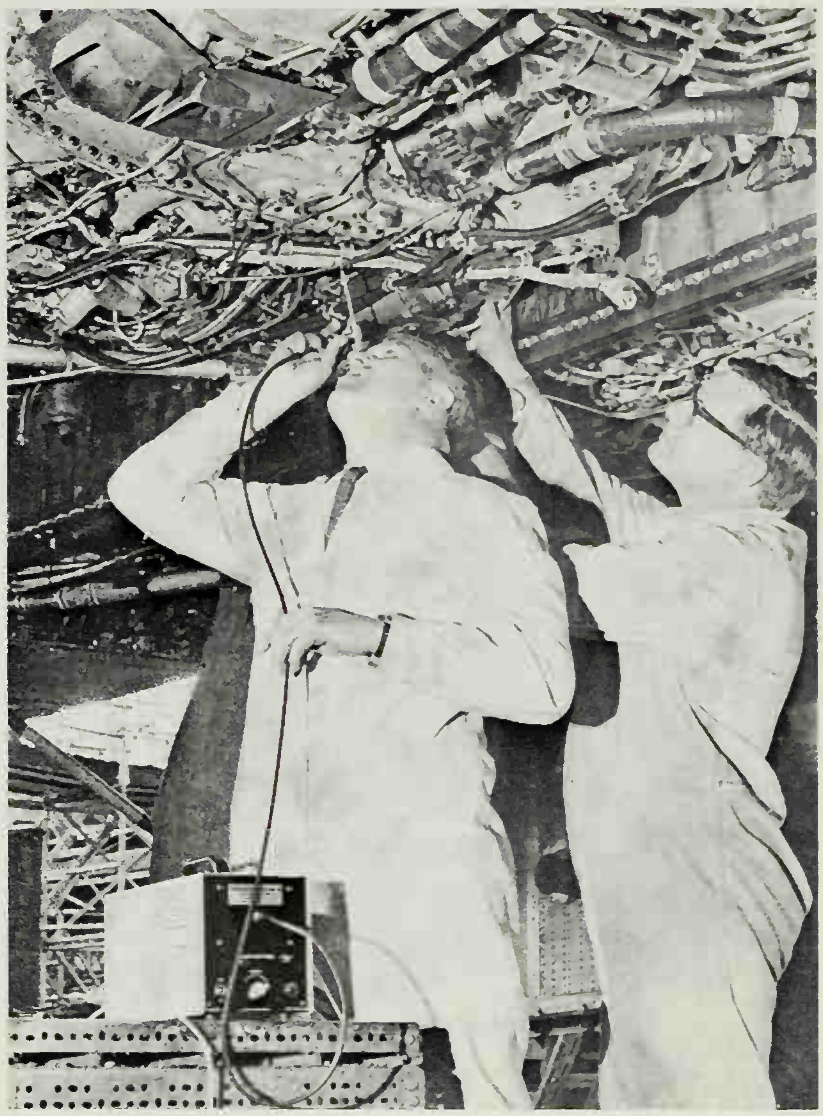
Endoscopes

for visual inspection in confined spaces



Above: Endoprobe, showing portable light unit, cable-type glass fibre light guide and three viewing probes

Below: Using an Endoprobe to check the installation of an Olympus 593 gas turbine *in situ* on a Concorde



Detailed inspection of materials, components and processes within spaces so confined that direct visual inspection is not possible is provided by the Endoprobe range of optical inspection instruments. They consist essentially of a high-intensity light source, a glass fibre light guide to direct the light to the area under inspection, and of a probe-type optical system for viewing.

The probe or 'telescope' is only a few millimetres in diameter and up to 1·5 m (58 in) long; it can easily be inserted through any existing hole into enclosed units, or past delicate components and complex wiring into intricate assemblies. Optical systems are available to give a broad or narrow angle of view in all directions, including backwards.

The probe includes fibre light guides (terminating at the objective lens) which project light from the 150 W projector-type lamp in a separate portable case on to the viewed area. The effective light output is 80 W, which is more than adequate not only for easy viewing, but also for photography and closed-circuit television; coupling adaptors between probe and photo-camera or TV camera are available.

Endoprobes are used by all British armed services, military and civil research establishments and industrial firms of every kind. Among the uses to which Endoprobes are being put are the inspection of boiler tubes and boiler shells, cylinders and crank cases of internal combustion engines, steam and gas turbines, cooling systems, hydraulic valves, gun barrels and breeches, air frames and aircraft control linkages, checking welds inside pressure vessels, chemical and nuclear plant, metallurgical and accident investigation and a variety of other applications.

By virtue of the fact that the light projected on to the viewed area from the end of the fibre light guide is completely 'cold' it is possible to inspect fuel tanks and similar hazardous areas without risk of explosion. The remotely located light source is fed at 21½ V from a mains transformer. The transformer input may be from any ac mains source, depending on specification.

Probes are fitted as standard with 1·8 m (6 ft) long plug-in cables for connection to the light unit; this cable carries the light guide fibres. Longer cables can be supplied if required and if some slight loss in effective light output is acceptable.

Specification

Telescope

Length: 24·5–150 cm (9–58 in) standard, special lengths on request
Diameter: for forward, lateral and fore-oblique viewing 8 or 5·5 mm; for rearward viewing 7 mm; special diameters on request
Optics: precision lenses giving 55°, 60° or 70° angle of view in forward, lateral and fore-oblique direction; 45° in retroview. Special narrow-angle (telephoto) lenses available on request. All lens systems are of fixed-focus type ensuring depth of field from 4 mm to infinity

Light unit

Light source: 150 W air-cooled standard projector lamp operating off 21·5 V built-in transformer fed from any mains supply
Light output: 80 W cold light at end of glass fibre light guide coaxial with telescope; light angle adjusted to correspond to angle of view
Dimensions: 30·5 × 15·2 × 18·4 cm (12 × 6 × 7½ in)
Weight: 5½ kg (12 lb)

Accessories

Instrument carrying case, camera adaptor

INSPECTION INSTRUMENTS (NDT) LTD
10–12 Emerald Street, London WC1, England
Telephone: 01-242 6105   Cables: Maygain London

Inspection equipment

for workshop and field use

Richmond Electronics has specialised in the manufacture and servicing of electrical, electro-mechanical and electronic instruments and equipment for use in ships and aircraft, both for the British Government and for manufacturers.

In addition to research, design and manufacturing facilities for the company's own range of products, Richmond Electronics operates an inspection organisation fully approved by the British Ministry of Technology, the Director-General of Inspection and the Air Registration Board.

The two products shown here were specially developed to assist and speed up inspection of components and equipment to the highest standards.

High-frequency eddy-current crack detectors

This detector was developed to locate minute cracks in metal parts. It was a small hand-held probe coil. When placed on the part to be tested, the coil induces eddy currents in the metal. The eddy currents in turn react on the coil. Discontinuities, no matter how fine, disturb the reaction. The disturbance is proportional to the depth of the defect.

Cracks can be located even under oxide or paint films. Different probes are available for ferrous, non-ferrous and low-conductivity metals such as austenitic stainless steels. The shape of probes can be adapted to the work, but standard probes cope with the majority of tasks, including blind bores and holes.

The unit is of the mains/battery type: when plugged into the mains supply the cadmium nickel cells are automatically recharged.

The overall dimensions are 320 × 210 × 240 mm ($12\frac{1}{2} \times 8\frac{1}{2} \times 9\frac{1}{2}$ in) and the weight is 6·35 kg (13 lb).

E.C. FLAW DETECTOR

The Richmond eddy-current flaw detector

Rotary indexing and tilt table Mk 3

Rotating and tilt table Mk 3

A range of precision rotary indexing and tilting tables is available for measuring and graduating angular position in two planes, for checking the performance of gyroscope equipment of all types, for testing accelerometers in specified planes and for similar duties.

The tables differ only in their load capacity and in mechanical design details arising from differences in size, but all models have full 360° rotation in azimuth and 135° (from −45° through vertical to +90°) in tilt. Accuracy is to 1 minute of arc, read off a scale engraved on the collar of the handwheel used to drive the worm-and-wheel mechanism. The tilt axis mechanism has an additional protractor and vernier scale reading to 1 minute of arc, which is unaffected by any wear which may develop in the worm-and-wheel drive.

Also available are polar axis tables designed especially for rapid testing of gyro equipment. The rotary platen is set to a fixed inclination corresponding to the latitude of any point on earth. Rotation is by electric motor, normal speed being one revolution in 2 hours 24 minutes.

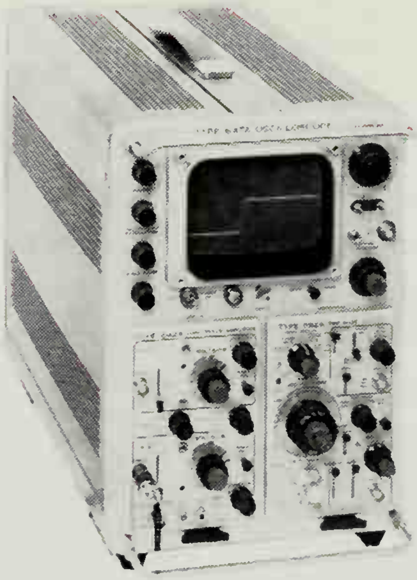
A spring-loaded clutch allows manual rotation through 360° for setting-up purposes.

In addition to the equipment briefly described here, Richmond Electronics also manufactures comprehensive gyro test tables, angle and torque testing equipment, laboratory standards and similar test equipment. Battery test equipment is described elsewhere in this Catalogue.

RICHMOND ELECTRONICS (MARKYATE) LTD
Hicks Road, Markyate, St Albans, Hertfordshire, England
Telephone: Markyate 761

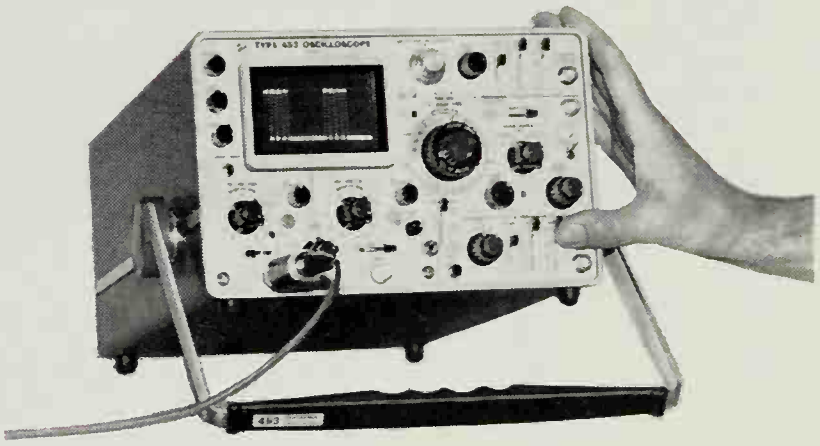
Oscilloscopes

for base and field use



Type 422
The Type 422 is a portable dc to 15 MHz dual-trace oscilloscope that combines small size and light weight with the ability to make precise waveform measurements. It weighs less than 10 kg (22 lb) and is ruggedly constructed to withstand shock, vibration, and other extremes of environment. Solid-state design, using field-effect transistor (FET) input circuitry, provides minimum drift and fast stabilisation time. No longer need measurements be compromised due to adverse field conditions; the Type 422 brings the precision of the laboratory to the field.

Two models are available: one operates on ac, the other on ac or dc, with an optional battery pack providing up to five hours' operating time for completely portable operation.



Type 454
This oscilloscope offers convenient measurement of fast-rise pulses and high-frequency signals previously beyond the capability of most conventional real-time oscilloscopes. Rise time is 2·4 ns, bandwidth is 150 MHz, with or without probe.

The two channels of the Type 454 provide cascaded single-trace displays at 1 mV/div, as well as X-Y displays to 5 mV/div. The dual-trace vertical system displays either channel separately, adds channels algebraically, alternates between channels, or chops between channels at a 1-MHz rate.

A time-base system with calibrated sweep delay permits highly magnified displays of small portions of undelayed sweeps, accurate measurement of waveform time jitter, precise time measurements, and many other types of measurement.

The Type 454 is mechanically designed to withstand environmental extremes and rough handling in transit. Plug-in transistors provide ease of maintenance.

Type R454 (the rack-mounted version) is electrically identical to Type 454 but is mechanically designed to mount on tilting slide-out tracks in a standard 19-in rack.

TEKTRONIX LIMITED
PO Box 36, St Peter Port, Guernsey, Channel Islands
Telephone: Guernsey 23411 Telex: 41193

Type 647A
(military version Type CT 536A)
This is a compact, high-performance instrument capable of accurate measurements over an ambient temperature range from –30 C to +65 C. Accuracy is even better in normal ambient temperatures ranging from 0 C to +40 C.

This oscilloscope offers bandwidth from dc to 100 MHz with or without probes when used with the Type 10A2A dual-trace plug-in unit. Triggering over the entire 100-MHz bandwidth is possible with a type 11B2A sweep-delay time-base unit.

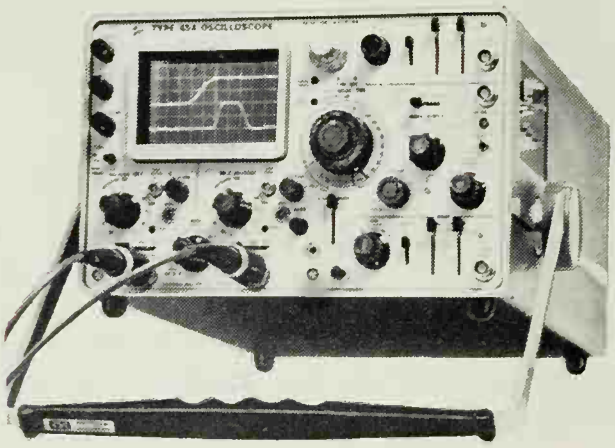
An accelerating potential of 14 kV provides a small, bright CRT spot with corresponding high writing speed. An internal 60 × 100 mm graticule with variable illumination offers parallax-free measurements.

A quick-change line-voltage selector permits simple and convenient adaptation to six different line-voltage ranges.

Type 453
The Type 453 is a portable, wide-band, dual-trace oscilloscope designed to withstand rough transport and other environmental extremes. Bandwidth is dc to 50 MHz (with or without supplied probes). Probes are miniaturised for easy access to dense circuitry.

The sharply-focused, bright trace provides a high-definition display compatible with the wide-band capabilities of the Type 453.

Solid-state design, with FET inputs, provides low drift and fast stabilisation time. Mechanical design features include plug-in transistors (for ease of maintenance), a front-panel cover (for use in transit or storage) with storage space for accessory items, and a carrying handle which can be rotated to several positions as a tilt-stand or for convenient carrying.



Ferrograph magnetic tape data recording equipment

The series Y range of professional magnetic tape recorders is well suited for a wide range of instrumentation and data recording tasks, in addition to audio recording, monitoring and test purposes.

Ferrograph Series Y recorders are available in single- and two-channel form, both recording in the half-track mode on 6·35 mm (¼-inch) tape; a full-track model, the Y715H, is also available.

Recording speeds of 38, 19, 9·5, 4·75 and 2·38 cm/sec (15, 7½, 3¾, 1⅞ and 15/16 in/sec) are available in various combinations.

Housed in a robust metal cabinet, all models can be operated horizontally or vertically free-standing or mounted in 482 mm (19-inch) racks. Ferrograph recorders are standard equipment in many military and civil organisations in many countries.

The Ferrograph Company Ltd
The Hyde, Edgware Road, Colindale, London NW9, England Telephone: 01-205 2241 Cables: Britferro London NW9

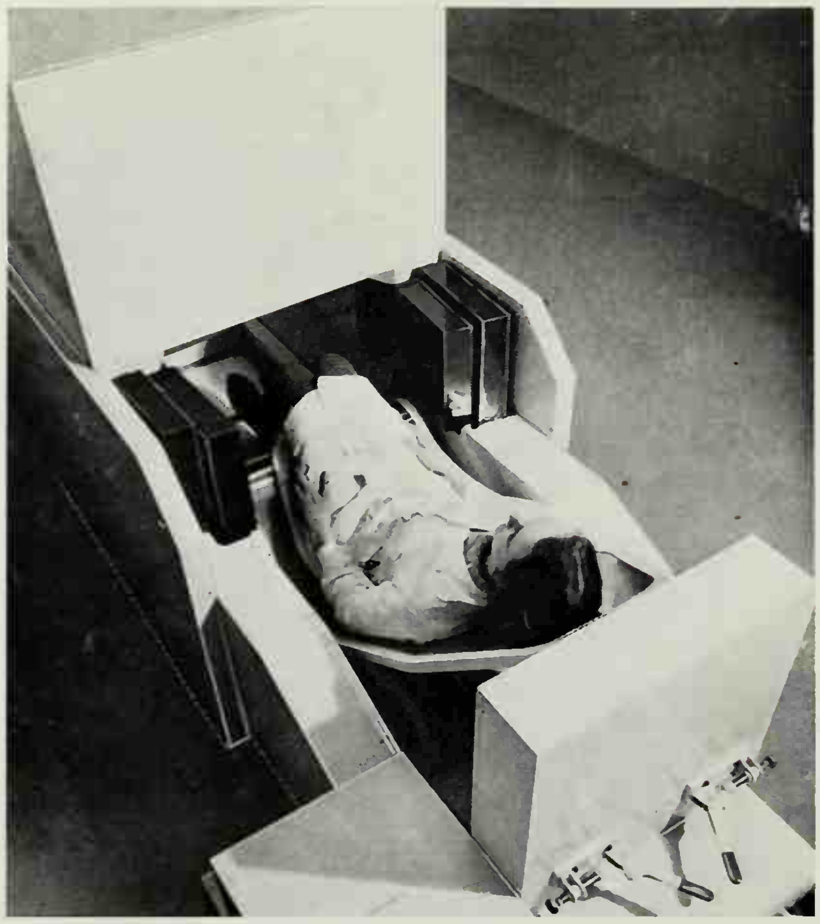
Unbreakable nylon syringes

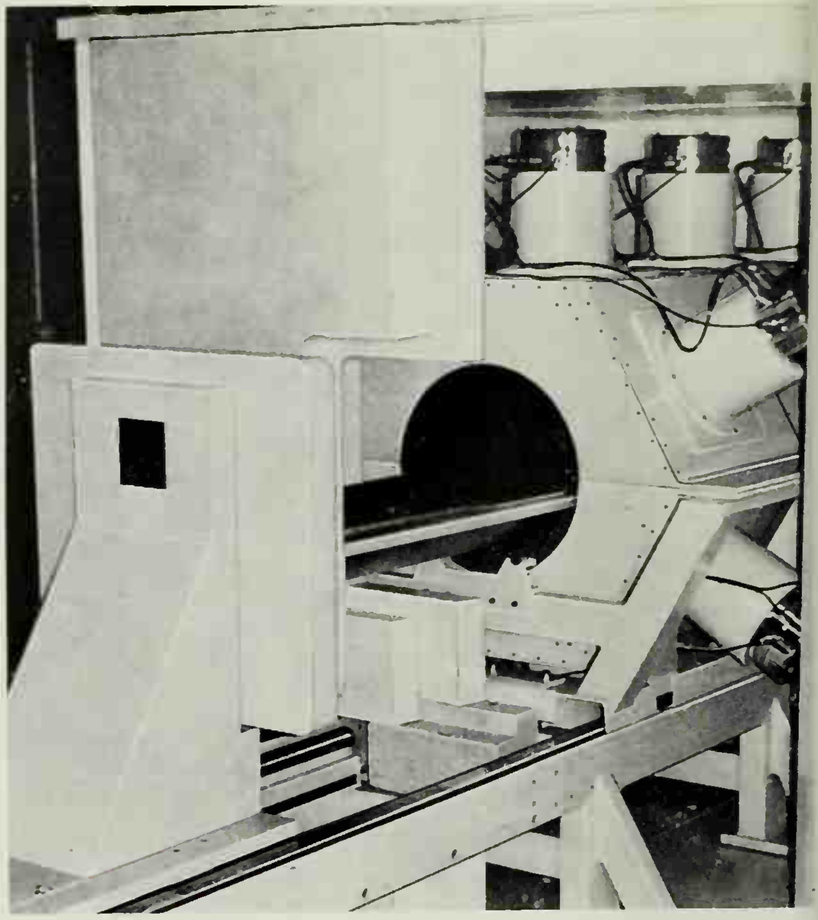
Used in testing for the presence of water in petrol, these syringes offer the following advantages: made of nylon throughout they are virtually unbreakable; barrels and pistons are fully interchangeable; the washer which provides the suction seal is replaceable; graduations, in colour, are permanent. Stock sizes are for 2 ml, 3 ml, 5 ml, 20 ml and 50 ml samples.

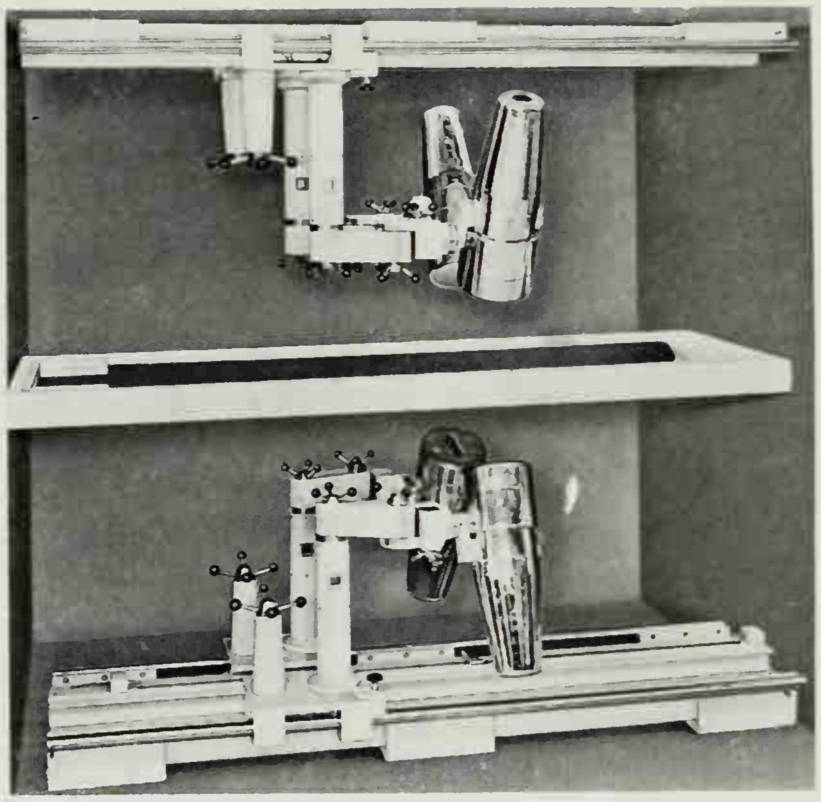
Chas F Thackray Ltd
PO Box 171, Park Street, Leeds, LS1 1RQ, England Telephone: Leeds 20085 Cables: Aseptic Leeds Telex: 55293

Section 35

Medical supplies and equipment





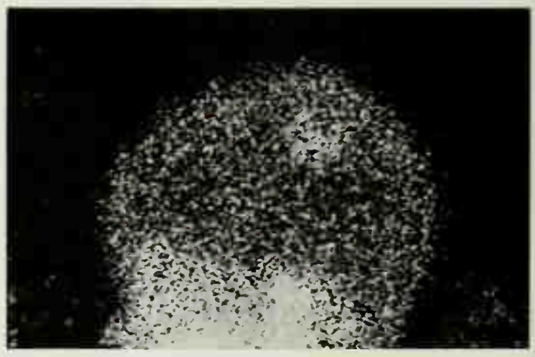


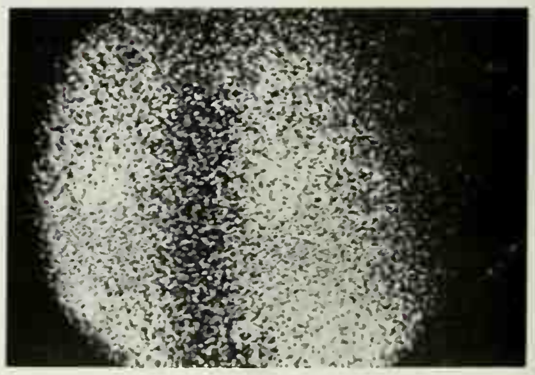
Above left: Nuclear Enterprises' NE 8109 shadow shield counter installed at Medical Research Institute in England features single 280 mm dia × 100 mm (11 in dia × 4 in) depth NaI(Tl) crystal mounted above patient. Scanning couch can be used either with patient in prone position or in static arrangement with patient in seated position. Minimum detectable body burden of Ra^{226}″ in a 15-minute count is approximately 5·10-^{9}C

Above right: NE 8107 4π plastic scintillator whole-body counter installed in hospital in Liege, Belgium. Counting efficiency exceeds 50 percent for 1 MeV gamma radiation, and counting time of 200 seconds yields body potassium values accurate to 5 percent in Nuclear Enterprises steel room Type SR-4

Left: NE 8102 system installed in Rumania features four 120 mm dia × 100 mm ($4\frac{3}{4}$ in dia × 4 in) depth NaI (Tl) crystals, capable of horizontal, vertical and rotational movement. In addition, there is a scanning mechanism, with slot collimator for crystals, to provide activity profile. Minimum detectable body burden of Ra^{226}″ in a 15-minute count is 3·10-^{9}C in Nuclear Enterprises steel room Type SR-1

Below: The illustration at the bottom left shows the NE Scinticamera Mk 3 being used for kidney investigations, while the two small illustrations at the right show two typical radiograms obtained with the equipment. The upper shows the brain, left lateral, indicating a tumour (dose 5 mc ^{99m}Tc, 2 × 10^{4} dots, 30 sec exposure 1 hour after injection). The lower shows normal lungs (by ventilation, using ^{133}Xe, dose 40 sec)





Radiation monitors

for medicine, research and health control

Nuclear Enterprises Limited manufactures a very wide range of monitors for measuring radioactivity in man and in his environment. This activity may have been induced deliberately for diagnostic and medical research purposes, may result from accidental exposure to radioisotopes or radioactive fall out, or may occur naturally.

Brief descriptions are given of three categories of monitors to illustrate the scope of the range. Many of the larger systems, however, are constructed to meet particular monitoring requirements after consultation with the company's systems specialists.

Whole-body monitors

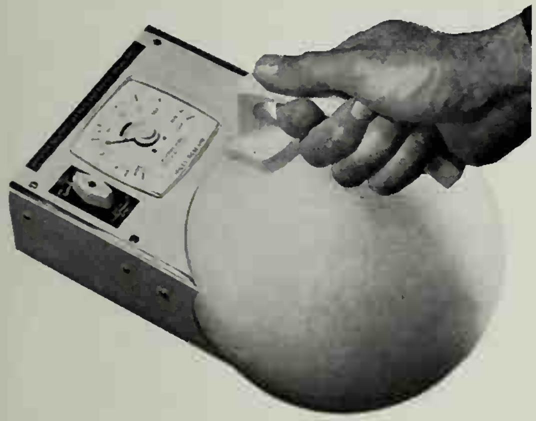
These monitors consist of a shielded detector unit and an electronic control unit for scanning and recording of information. Five basic systems are offered: NE 8102 four-crystal scanning counter, and NE 8103 large single-crystal counter for general medical diagnostic and research purposes and for reactor and accelerator personnel monitoring; NE 8107 4π plastic scintillator counter (the patient is completely surrounded by the detector) for natural K^{40} determination, and the lower-cost NE 8108 and NE 8109 'shadow shield' monitors with minimal shielding for medical diagnostic work where the highest sensitivity is not essential. Old steel (pre-1945), free of internal fission product activity, is used for shielding rooms and all materials used in monitors are carefully selected for low background radioactivity. See illustration opposite.

Scinticamera NE 8251

This equipment is used for examining the distribution of radioisotope-labelled compounds in the kidneys, brain, thyroid, liver, and other organs and glands of the body. It is simple to operate and photographs can be taken from any angle. Results are obtained in less than two minutes with a Polaroid camera. Automatic dynamic sequences of pictures can be taken with frame speeds up to three pictures per second. Computers and other data analysis systems are available as shown opposite, bottom left.

Health physics instruments

This extensive range includes: hand and clothing monitors, dose ratemeters, portable contamination monitors and neutron dose rate monitors. Three monitors are described below. All were developed in co-operation with the United Kingdom Atomic Energy Authority at Harwell, England.



0075 neutron monitor

The 0075 neutron monitor is a light-weight, self-contained, portable (it can be held in one hand), battery-operated instrument designed to measure neutron dose equivalent rate over a wide range of neutron energies while having a negligible response to gamma radiation. Its gamma rejection ratio is better than 3000:1 up to at least 1 r/h for a photon energy of 100 keV. Readings are on a quasi-logarithmic scale calibrated from 0·5 mrem/h to 1 rem/h

0030 beta-gamma doserate meter

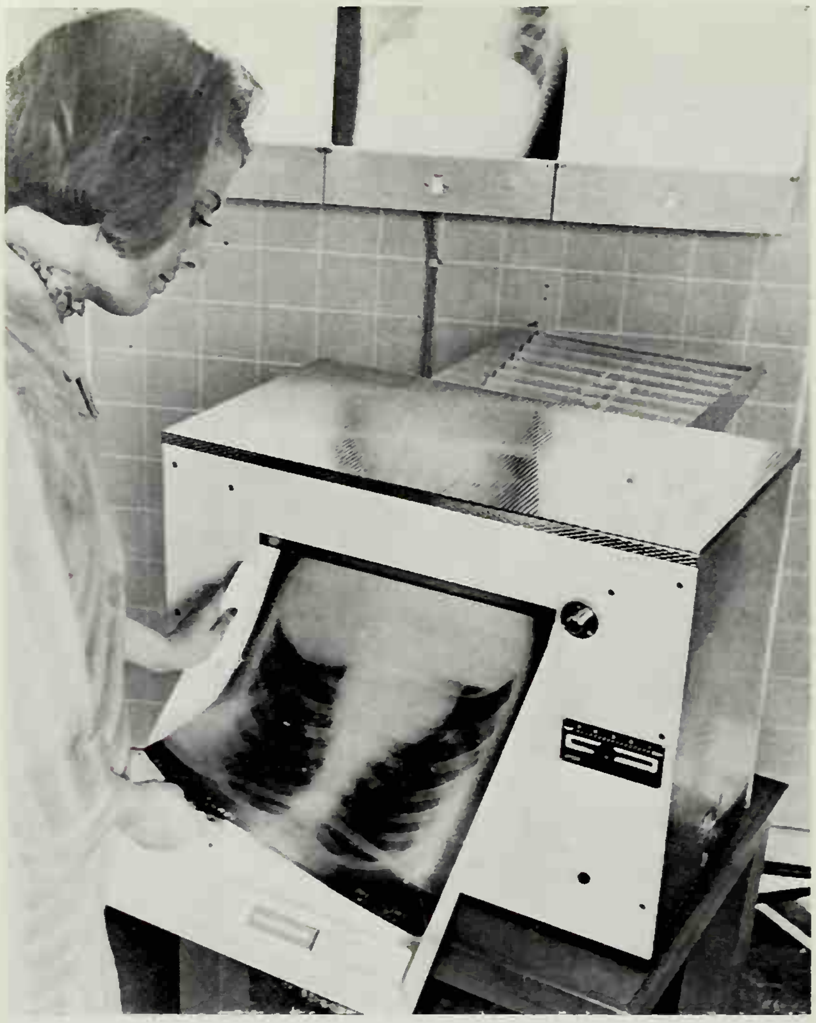
This is a general-purpose doserate meter which gives reliable and accurate readings of beta and gamma radiation over a wide energy range. It is light and portable and operates on a U2 flashlight battery. Its simple controls make it suitable for use in laboratory or factory. It incorporates a high-stability thin-window ion chamber and is radio-frequency shielded for use with linear accelerators and betatrons. Its range is 1 mr/h to 8 r/h

2601/2602 gamma radiation monitors

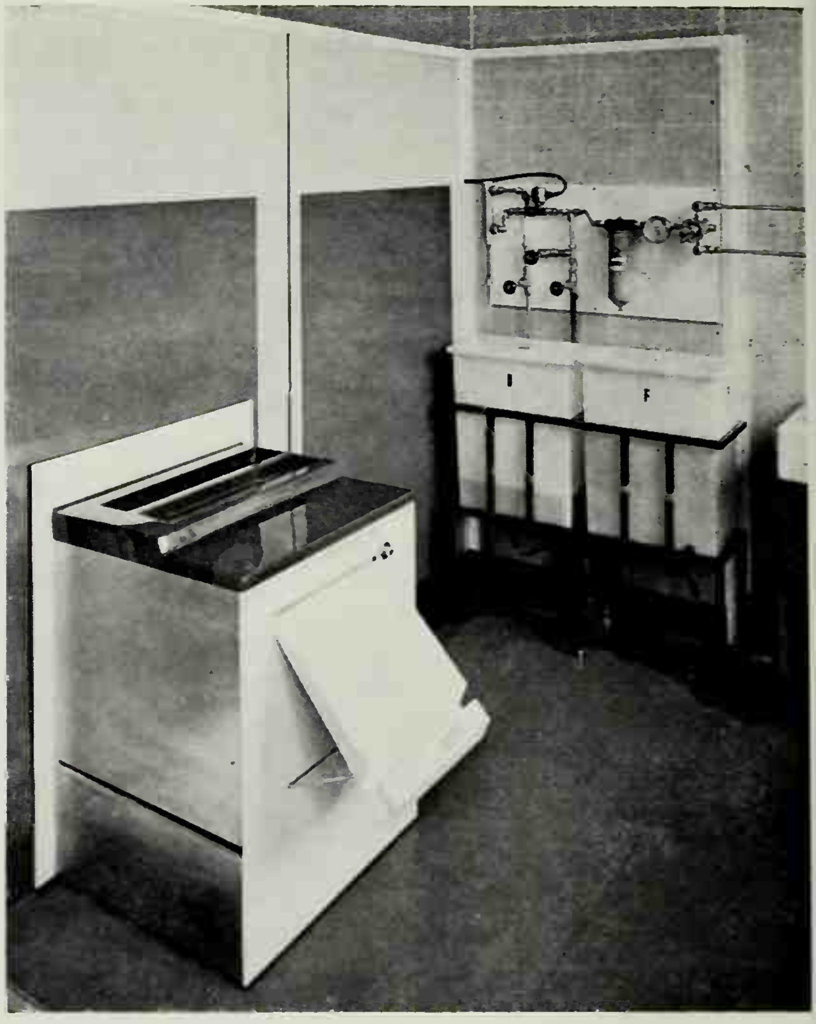
These are single-range portable instruments to measure radiation levels of the order of 5 μrad/h to 10 mrad/h (2601), and 100 μrad/h to 200 mrad/h (2602). Fully transistorised, battery-operated and easy to operate and read, the instruments are particularly suited to radiation surveying and contamination monitoring in accordance with current statutory ionising radiation requirements. They have a Geiger-Muller tube as detector, which is fitted with special correction filters so that doserate indication remains accurate within $\pm$20% over the energy range 45 keV to 3·0 MeV

NUCLEAR ENTERPRISES LIMITED
Sighthill, Edinburgh, EH11 4EY, Scotland
Telephone: 031-443 4060 Cables: Nuclear Edinburgh Telex: 72333

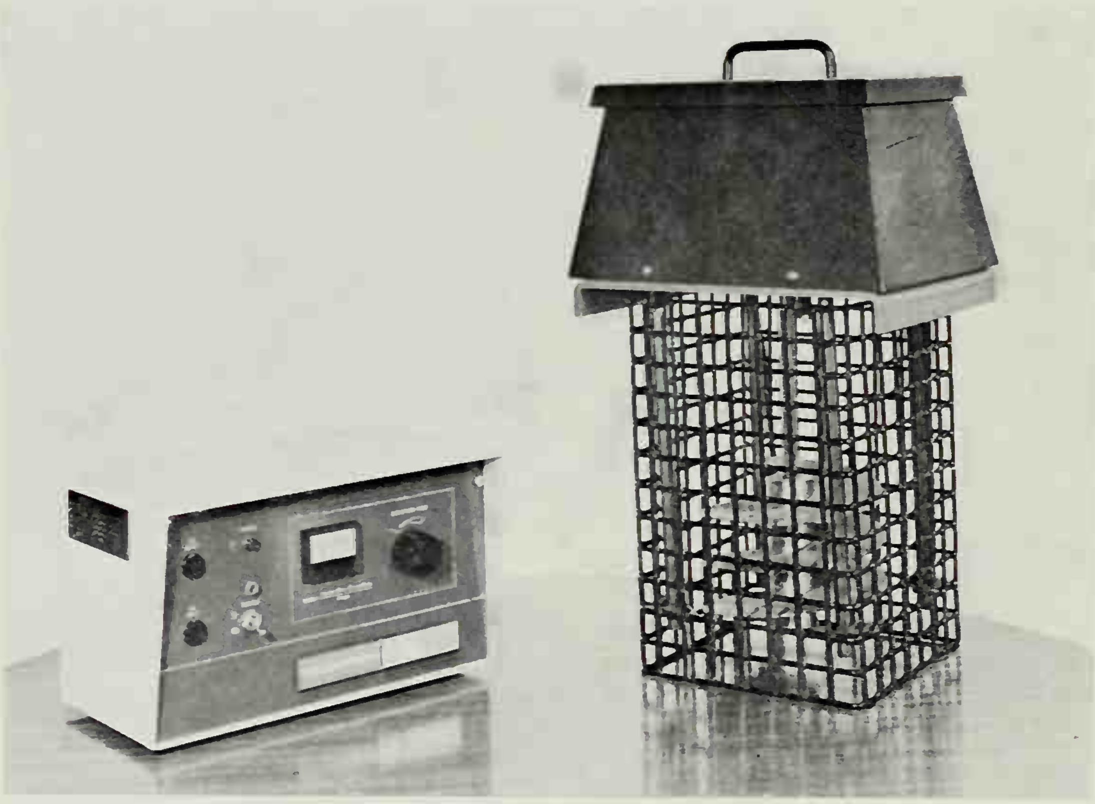
1966



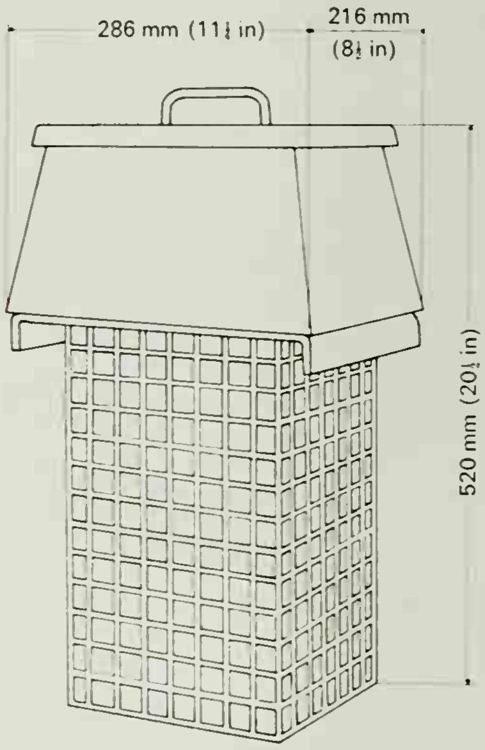
The Williamson 900 film dryer is intended for use where film must be developed separately but where scratch-free dry films free from drying marks are required for immediate use. High-speed drying is by means of filtered hot air blown across both sides of the film in a specially contoured chamber

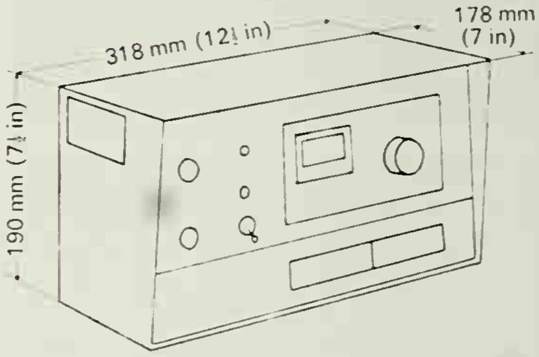


The Williamson 90-second RP x-ray film processor develops, fixes, washes and dries film reliably, consistently, safely and fully automatically in a 90-second cycle. The unit is shown here in a typical installation with mixing valve, water shut-off valve and external bulk replenishment tanks



The cost of the Williamson silver recovery unit is recouped in a few months' operation through the value of recovered silver. In addition, the useful life of the fixing bath is considerably extended. Extraction of silver also makes possible the use of replenishers, thus considerably reducing the cost of fixing. Once switched on, the unit operates automatically





The equipment described here is only part of the wide range of products made by Williamson Manufacturing Co Ltd. Some of the aerial reconnaissance cameras made by this company will be found described elsewhere in this Catalogue, while details of other products and advice on the equipment and organisation of medical, military and industrial photographic departments are available from Williamson.

Film processing units

for medical x-ray departments

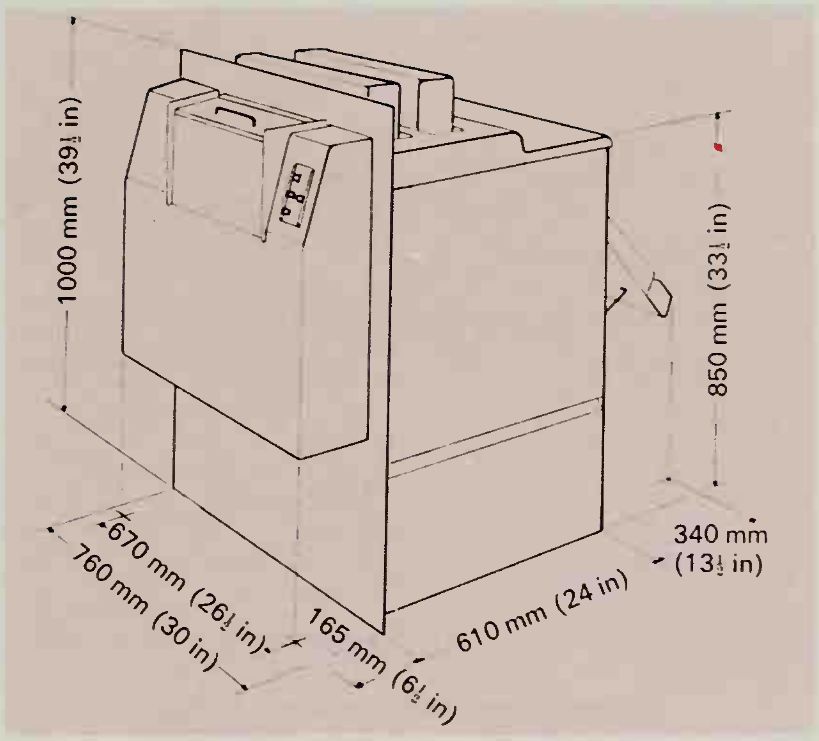
The smooth efficiency of x-ray departments is always important but at times of emergency it can be literally a matter of life and death.

Based on our experience of over 30 years in the design and manufacture of photographic cameras and equipment of all kinds, we have now developed a range of ancillary units which drastically reduce the time between exposure and availability for inspection of x-ray film. These and other units considerably increase the cost-effectiveness of radiographic sections.

90-second RP x-ray film processor
This unit has a standard dry-to-dry cycle (developing, fixing, washing and drying) of 90 seconds, but can be converted to a 3½-minute cycle if required. Using a minimum of water and power it can process up to 85 cut sheets of conventional 254 × 305 mm (10 × 12 in) x-ray film per hour. The unit is self-contained.

Specification

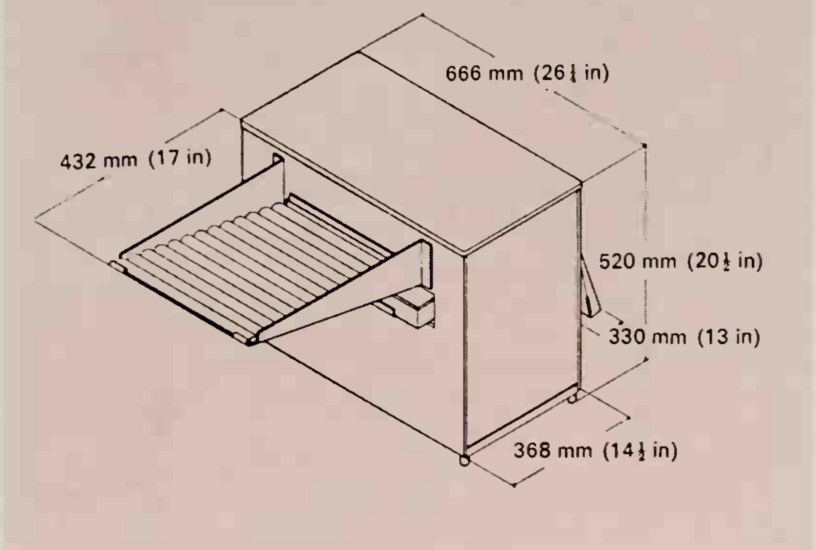
Processing time, dry-to-dry: 90 sec
Processing rate (90-sec process): 24·3 m/h (80 ft/h)
Output: 85 cut sheets of 254 × 305 mm (10 × 12 in) or equivalent
Film sizes: 100 mm (4 in) min length; 355 mm (14 in) max width
Wash water flow rate: 6·75 litre/min (1·5 gal/min)
Power consumption: less than 15 A at 200–240 V, 50 Hz
Integral replenishment: two 5-litre (1·1 gal) bottles mounted on top, sufficient for approx 100 cut sheets 254 × 305 mm
External bulk replenishment: two separate 70-litre (15-gal) tanks sufficient to develop 1800, fix 1200 cut sheets 254 × 305 mm
Accessories: automatic feeder unit, silver recovery unit (see below)
Weight: 122 kg (270 lb) dry
Dimensions: see sketch on right



Type 900 film dryer
This bench-mounted unit was designed for the rapid, safe and scratch-free drying of x-ray and other film. Speed is adjustable by the operator over the range from 11 m to 22 m (450–900 in) per hour. The built-in 1 kW heater is thermostatically controlled and heats the air which, after being filtered, is blown by a fan over both sides of the film to be dried. Design is aimed at greatest simplicity of operation and maintenance

Specification

Design: unit construction, integral squeegee rollers
Drying rate: 11 to 22 m (450–900 in) per hour
Output: 45–90 cut sheets of 254 × 305 mm (10 × 12 in) or equivalent
Film size: 100 mm (4 in) min length; 355 mm (14 in) max width
Power consumption: 7 A at 200–240 V single-phase 50 Hz
Heater: 1 kW, thermistor-controlled
Weight: 60 kg (130 lb)
Dimensions: see sketch on right



Williamson silver recovery unit
Considerable amounts of silver are reduced out in the fixing bath in busy processing departments. Silver recovery can greatly improve the cost-effectiveness of such departments through the recovery of silver and by extending the life of fixing baths.

The Williamson silver recovery unit is a simple, compact and reliable electrolytic unit. The cathode takes the form of an impeller within the anode cage. This design permits the use of a 3-ampere current, which provides a recovery rate of up to 12 grammes per hour of silver of 98·2 percent purity. The unit requires no operator.

The overall dimensions are shown in the diagram on the opposite page. The weight of the electrolytic operating unit is 8·2 kg (18 lb), that of the control unit 6·8 kg (15 lb).

Practical experience in hospitals, photo-reconnaissance and other photo-processing units, both military and commercial, has shown that the cost of the unit can be recovered within a few months of operation through the recovery of silver.

A member of the Negretti & Zambra Group
WILLIAMSON MANUFACTURING CO LTD
Hawthorn Road, London NW10, England
Telephone: 01-459 0073 Cables: Kinetogram London NW10 Telex: 25842

WILLIAMSON

Sterile surgical gloves

for immediate theatre use

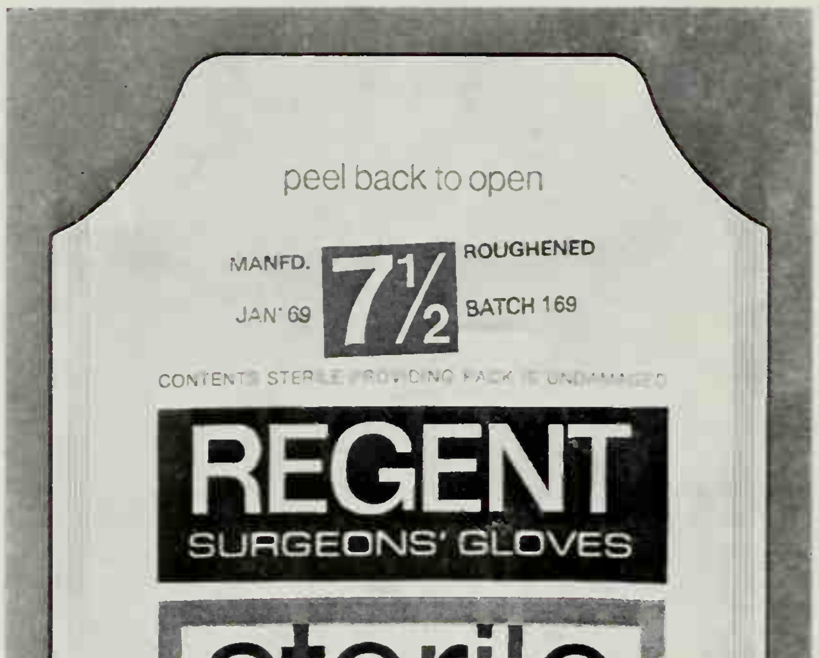
Regent sterile surgical gloves are supplied powdered with absorbable dusting powder to British Pharmacopoeia specification ready for immediate theatre use and can be resterilised afterwards for ward use. Supplied in cartons containing 36 pairs of one size, the gloves are available in the following types and sizes:

straight finger, brown, rough finish,
sizes 5½ to 9½ inclusive
straight finger, brown, smooth finish,
sizes 5½ to 9½ inclusive
curved finger, white, smooth finish,
sizes 6 to 9 inclusive

Regent gloves are produced from latex which provides much higher extensibility and lower modulus than are obtained with gum rubber. They are thin, to give maximum sensitivity, but have a tensile strength more than sufficient for orthopaedic surgeons using heavy instruments. The gloves are packed in an inner wrapper and enclosed in an envelope made of polythene-coated bleached kraft paper, heat-sealed on all sides. Because a complete skin of polythene forms the inner face of the pack, it can be considered waterproof and the gloves remain sterile indefinitely provided the pack is undamaged. The outer envelope is simply peeled back to expose the inner sterile wrapper.

Sterilisation is by gamma irradiation (cobalt 60: dose level 2·5 Mgrads). Batches of gloves are irradiated at units approved by the British Department of Health and certificates are issued at the irradiation unit confirming that a minimum dose of 2·5 Mgrads has been given.

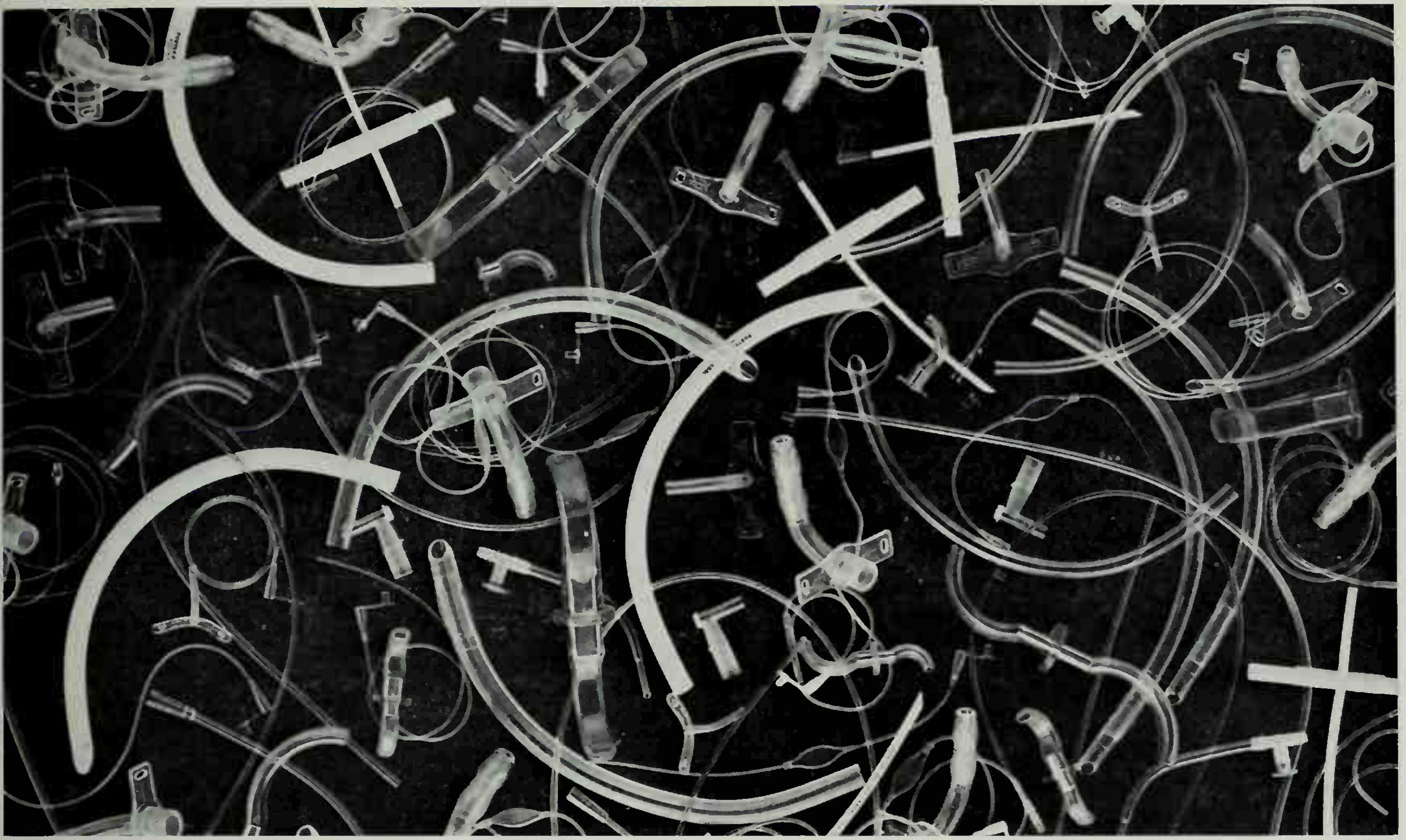
Additional information and samples of Regent gloves are available on request.



L R INDUSTRIES LIMITED
North Circular Road, Chingford, London E4, England
Telephone: 01-527 2377 Cables: Lonrubmanf London E4 Telex: 21644

Plastics products

for surgical and medical uses



Portex Ltd, one of the world's largest manufacturers of medical and surgical products, now has more than 1400 different items in use in hospitals throughout the world. Of these, over a thousand are made by Portex, the remainder includes medical equipment such as the Cornercroft human isolator, Cardiff peritoneal dialysis machine and Selflex guide wires.

Apart from the very wide ranges of tubing, connectors and adaptors, the majority of products is grouped in the various specialised fields of anaesthetics, cardiology, transfusion, gastroenterology and urology. A considerable number of new products has been added to these groups during the first six months of 1970, most of them for use in anaesthetics. All are manufactured from surgical quality non-toxic plastics.

Of these new products one in particular has been designed and made in response to numerous requests for 15 mm endotracheal adaptors and a swivel connector. Conforming to internationally recommended standards for fittings on anaesthetic equipment, the set comprises 12 adaptors ranging from 2·5 mm to 11·5 mm and the swivel connector which rotates through 360°. Use of this connector provides the advantages of considerable flexibility of positioning between patient and anaesthetic apparatus; it also allows suction to be effected without interruption to gas flow.

The latest Portex products for use in oxygen therapy range from a simple nasal catheter (the Addis) made from soft translucent medical grade PVC, to the Derbyshire oxygen chair for use in paediatrics. This chair affords continuous oxygen therapy for infants while they remain completely accessible for other forms of treatment, feeding and nursing. The nasal oxygen set is specially designed for patient's comfort, having adjustable nasal tips and harness. It has a connecting tube 1·5 m in length, fitted with a coned connector. The set, supplied sterile, is ideal for use in intensive care units.

Disposable endotracheal suction tubes are now machine-made so that the large quantities produced are offered at very low prices. Seven sizes are available, 37·0 mm long, with terminal or lateral eye and they are individually packed, sterilised and presented in cartons of one hundred. An endobronchial suction catheter manufactured from transparent non-toxic PVC has also been added to this group of products.

Since the introduction of the Bristol blood warmer, Portex has gone into production on an infusion coil which offers exceptionally high flow rates at body temperatures. This was the outcome of considerable research into the thermal conductivity of plastics, which was found to be highest in polythene used for the manufacture of these coils.

The new Portex auto-analysing tubing is made to the extremely high standards required of this product for work in hospital laboratories. A very soft PVC was specially formulated for the purpose since this plastics provides a definite flow rate within measurable limits. The tubing is marketed by Quickfit and Quartz.

PORTEX LIMITED
Hythe, Kent, England
Telephone: Hythe 66863 Cables: Portex Hythe Telex Telex: 96165

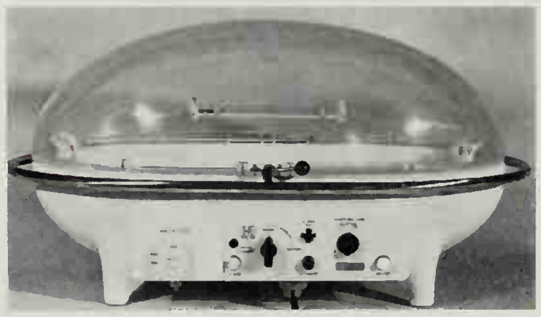
PORTEX

1970

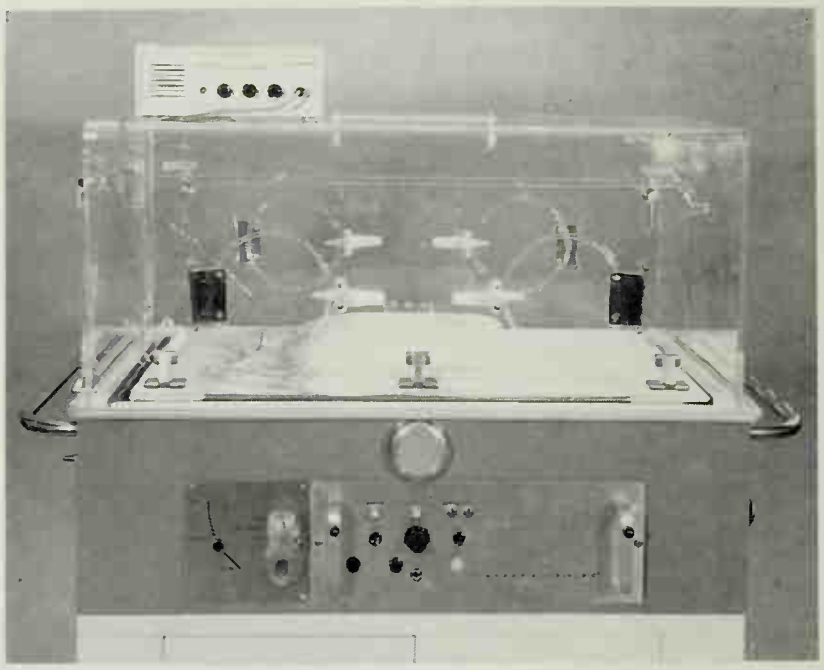
Medical engineering

Advanced systems of all kinds

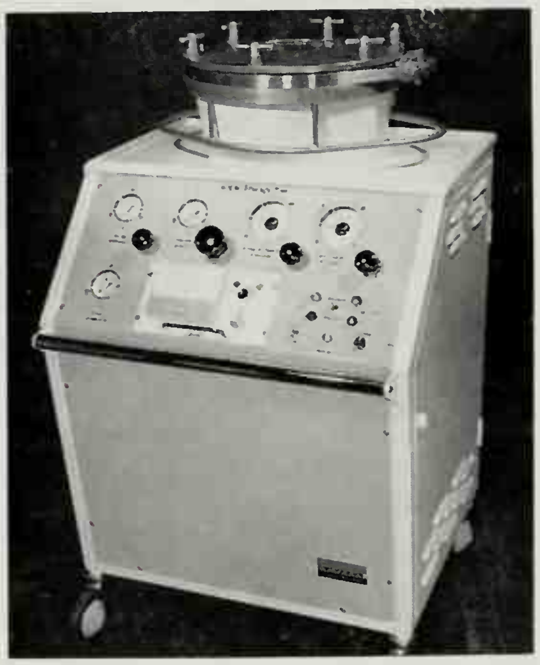
Vickers Medical Engineering is a division of Vickers Limited engaged on a continuing programme of research and development, ranging over all aspects of medical engineering. It has pioneered many new technologies and innovations. From infant incubators, oxygen therapy masks, oxygen tents, inflatable splints to the Multichannel 300 for mass body-fluid analysis, Vickers advanced engineering techniques offer the medical world systems and equipment designed to meet wide-ranging specialist needs in many fields.



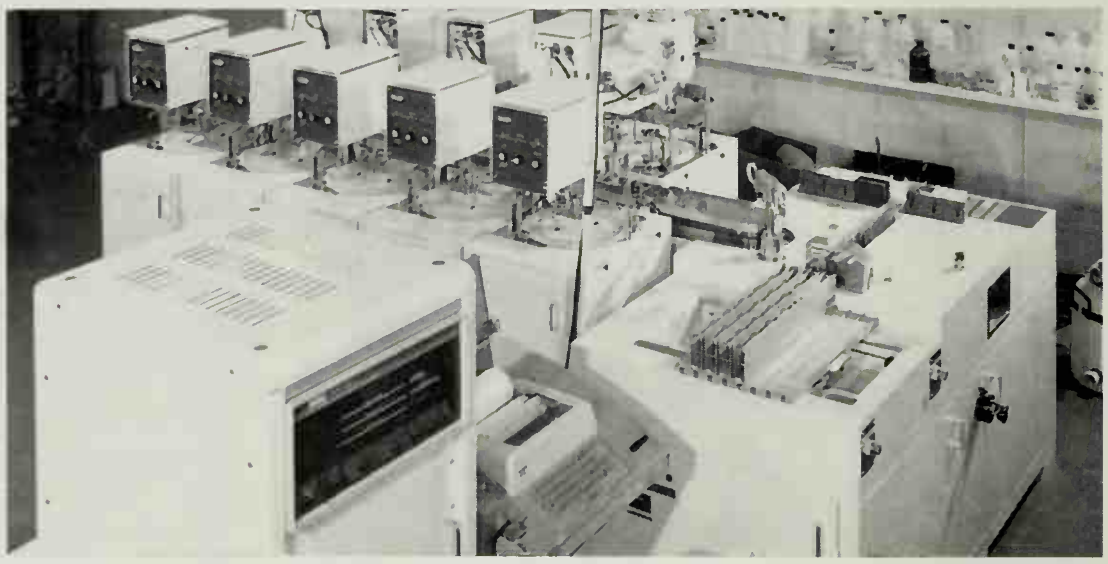
Portable neonatal incubator



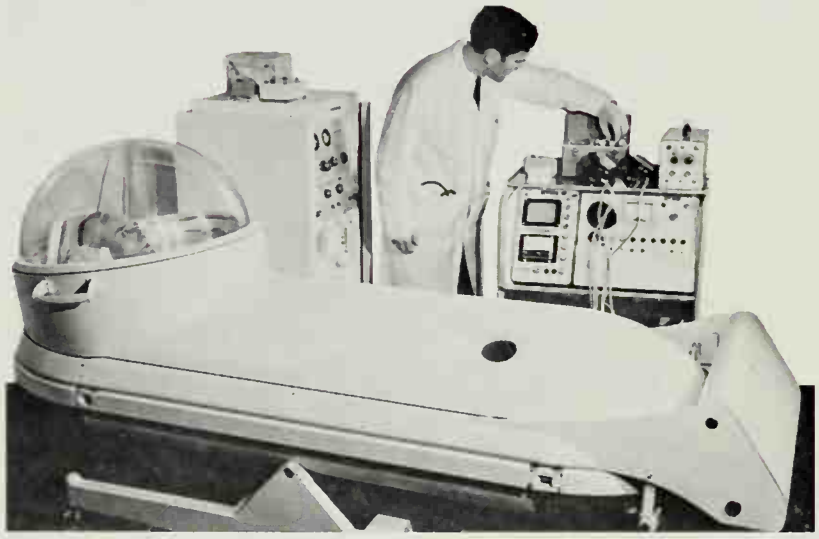
Five-nine nursing incubator and apnoea alarm



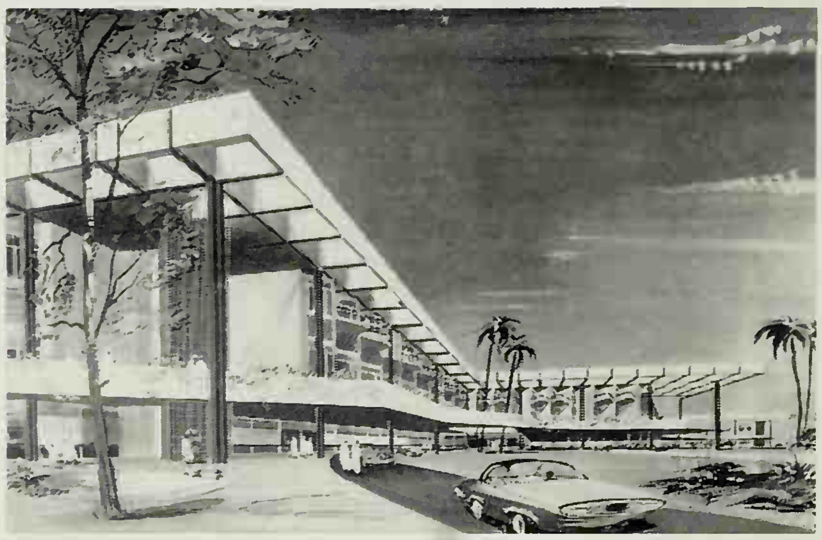
Tissue and organ storage unit (THS/4)



Laboratory automation with Multichannel 300 unit



Coronary and intensive care with a hyperbaric oxygen bed



Hospital design and engineering services

VICKERS LIMITED
Vickers Medical Engineering
Basingstoke Works, Priestley Road, Basingstoke, Hampshire, England
Telephone: Basingstoke 5151

Vickers

General anaesthesia and oxygen therapy apparatus, flowmeters and regulators

Medrex anaesthetic head: a simple and versatile apparatus providing Halothane vaporisation by either patient's breath or fresh gases. Particularly suited to relatively short procedures and offering efficient economical anaesthesia for dental surgeries, casualty, etc.

Marrett anaesthetic head: a compact and truly portable anaesthetic apparatus providing all facilities normally found in large anaesthetic machines.

Universal stand: a mobile cylinder stand with regulators, yokes and contents gauges to accommodate up to four cylinders. The Medrex head or separate flowmeters and vaporiser assembly may be attached to the universal mounting bar. Unit for oxygen therapy and aspiration; can be fitted to any cylinder stand or patient's recovery trolley.

Airmed Ltd
Edinburgh Way, Harlow, Essex England Telephone: Harlow 24331 Cables: Airmed Harlow Telex: 81338

Disposable transfusion and dialysis equipment and accessories

Avon Medicals designs, manufactures and markets a wide range of plastics disposable, single-use transfusion equipment and accessories.

Administration sets for blood and solutions include standard pattern sets, paediatric burette sets, Y-type blood sets, venous pressure warning coils, Guest cannulae and ancillary equipment such as rotary blood pumps and bottle suspenders.

Our disposable, single-use dialysis equipments include arterial and venous blood lines for Kiil dialysers, special designs for patients using arterio-venous fistula coil dialysers and ancillary equipment such as heparin administration lines and pump inserts for introducing peristaltic pumps.

All Avon Medicals products are totally sterile, pyrogen-free and individually packed.

Avon Medicals—Avon Rubber Co Ltd
1649 Pershore Road, Stirchley, Birmingham 30 England Telephone: 021-458 6324 Cables: Avon Medicals Birmingham 30

Hospital and laboratory sterilisers, vacuum embedding baths, water stills

Steam, gas and electrically heated vertical and horizontal cylindrical pattern autoclaves for working pressures up to 2·1 kgf/cm^2 (30 lbf/in^2). Four standard sizes are available, all suitable for sterilising media, glass, porcelain or metal containers and other non-porous laboratory ware. The body of heavy gauge internally hand-tinned copper with gun-metal closure is encased in stainless steel for strength and cleanliness. Easily operated and maintained. Every electric model is fitted with automatic cycle control. Similar controls can be fitted to gas and steam sterilisers at extra cost.

Rectangular models for gloves and dressings are also available.

Copper water stills provide standard BP or pyrogen-free distillate for medical and industrial use.

Brown & Son (Alembic Works) Ltd
10–11 Lime Street, London EC3, England Telephone: 01-626 1801 Cables: Rawsonship London EC3

Automatic lavatory for wounded and handicapped

The Clos o Mat lavatory enables personnel with bandaged hands or without hands to attend to their personal hygiene without help, thus providing privacy and saving attendants' time.

On pressing a foot switch a nozzle advances and sprays water at body temperature while the pan is flushed. The nozzle then retracts, giving place to a flow of warm air for 2-3 minutes. A manual flushing handle also permits normal use.

Integral design with robust and compact construction render the Clos o Mat ideal for use in military hospitals.

Clos o Mat (Great Britain) Ltd
2 Brooklands Road, Sale, Cheshire, M33 3SS, England Telephone: 061-973 1234

Automated infusion unit

The Decca Type 460 Automated Infusion Unit provides continuous monitoring and control of the drip rate of all standard disposable giving sets (including micro drips) at any desired rate between 4 and 60 drips per minute. It can be mounted on any infusion stand and does not occupy any additional space round the bed. It can operate on all infusion fluids whether opaque or translucent, including blood, saline and drug solutions. Once set to the required drip rate the unit maintains this rate as long as required. Changing the drip rate (and operation in general) is very simple.

Decca Radar Ltd
Decca House, 9 Albert Embankment, London SE1, England Telephone: 01-735 8111 Cables: Decradar London SE1 Telex: 28588

Electro-medical equipment for physiotherapy; electro-surgical apparatus for operating theatres

Equipment for physiotherapy including units for short-wave therapy, micro-wave therapy, ultrasonic therapy, muscle stimulation, infra-red lamps and paraffin wax baths. Surgical diathermy equipment ranges from large machines capable of any surgical technique to small units for dermatology, etc.

Electro-Medical Supplies (Greenham) Ltd
Wantage, Berkshire, England Telephone: Wantage 4291 Cables: Galfarad Wantage

Sutures, ligatures, catgut, silk and related surgical products

Ethicon is Europe's largest manufacturer of surgical sutures marketing a range of catgut, silk and related materials designed for the most advanced operative techniques and in a variety of gauges and types, including the modern man-made fibres. Ethicon is Europe's premier surgical needle maker, swaging needles ranging from 6 to 110 mm, to all available materials.

Finished sutures, sterilised by Cobalt 60, are sealed in easily opened foil packets overwrapped and packed in a plastics box with colour-coded label to indicate the material from which the sutures are made. Each box becomes a drawer in a compact storage cabinet, thus simplifying suture storage.

Ethicon also makes examination gloves, glove powder, scrub soap and related surgical products.

Ethicon Ltd
Sighthill, Edinburgh, Scotland Telephone: 031-443 4050 Cables: Ligatures Edinburgh

Laboratory automation systems

Joyce, Loebl offers a wide range of medical and industrial laboratory instrumentation for research and routine analysis. Fully automated and mechanised systems are available for microbiological tests, enzyme rate analysis, flame photometry, folate activity, sequential solvent extraction, on-line colorimetry, particle size analysis, RNA fractionation, electrophoresis, etc. Many methods are available.

Sample presentation by recorded plateaux, digital display and printout, punched card and tape, etc, is available according to instrument type and user requirement.

Joyce, Loebl & Co Ltd
Princesway, Team Valley, Gateshead, Co Durham, NE11 OUJ, England Telephone: Gateshead 877891 Cables: Jayell Gateshead Telex: 53257

Hospital laboratory and dispensary furniture and fume extraction systems

Morgan and Grundy, Europe's largest specialists in laboratory furniture and equipment, meets the needs of over 40 countries. Hospitals and medical schools are offered a complete laboratory engineering service, backed by long experience of conditions throughout the world, including design, supply and installation, under a single comprehensive contract.

Laboratory furniture in four modular systems, each in wood or metal with work tops as required, gives the architect or user flexibility of choice.

A wide range of fume cupboards satisfies every laboratory need, from simple types for medical schools to the most sophisticated for handling toxic or radioactive materials.

Ovens, incubators, glassware and drying ovens for glassware and samples are also available.

Morgan and Grundy Ltd
Cowley, Uxbridge, Middlesex, England
Telephone: Uxbridge 38551
Cables: Grundylab Uxbridge
Telex: 21126

Hospital beds and ward equipment

Nesbit-Evans specialises in the design, manufacture and supply of hospital and institutional beds, furniture and bedding. The company is a contractor to the British Ministry of Health and Ministry of Supply for hospital beds. Priority is given to exports and a large proportion of the company's production goes to government and ministry hospitals of overseas administrations.

Catalogues are sent on request by return airmail

J Nesbit-Evans & Co Ltd
Wednesbury, Staffordshire, England
Telephone: 021-556 1511
Cables: Hospitabed Wednesbury

The Roehampton pre-sterilised burns dressing

Thousands of deaths and many more serious injuries result from burns every year. Risks are increased by the danger of infection and shock between the point of accident and hospital. The Roehampton dressing (UK Patent No 1029210) reduces these risks. It can be applied or removed in seconds, even by unskilled personnel, without causing further pain even on major burns.

The packs remain sterile until opened. Once applied, there is no risk of adherence for up to 24 hours. Dressings range from 76 × 38 mm (3 × 1·5 in) for small wounds up to 610 × 137 mm (24 × 54 in) for full body. Reviewed and accepted by the Ministry of Defence (UK), Food and Drug Administration (USA), Department of Scientific Studies (Canada) and Army Medical Services (Australia).

Price Brothers & Co Ltd
Wellington, Somerset, England
Telephone: Wellington 2216
Cables: Wool Wellington

Surgical instruments, hospital furniture and equipment

Thackray hospital equipment includes a comprehensive range of surgical instruments, specialist hospital furniture, surgical sundries and sterilising apparatus. These high-quality products have been designed and manufactured by Thackray for almost sixty years and are supplied to hospitals throughout the world.

Chas F Thackray Ltd
PO Box 171, Park Street, Leeds, LS1 1RQ, England
Telephone: Leeds 20085
Cables: Aseptic Leeds
Telex: 55293

Fracture equipment, folding wheelchairs, walking aids and rehabilitation equipment

Zimmer Orthopaedic manufactures many specialised items for use in orthopaedic surgery, nursing and rehabilitation.

Instruments are available for many operative tasks, while bone plates, knee and hip prostheses are made in both stainless steel and titanium allowing the surgeon to use the implant of his choice.

The world-famous Everest & Jennings folding wheelchairs are light in weight, yet strong and sturdy in use. Models are available to meet all requirements.

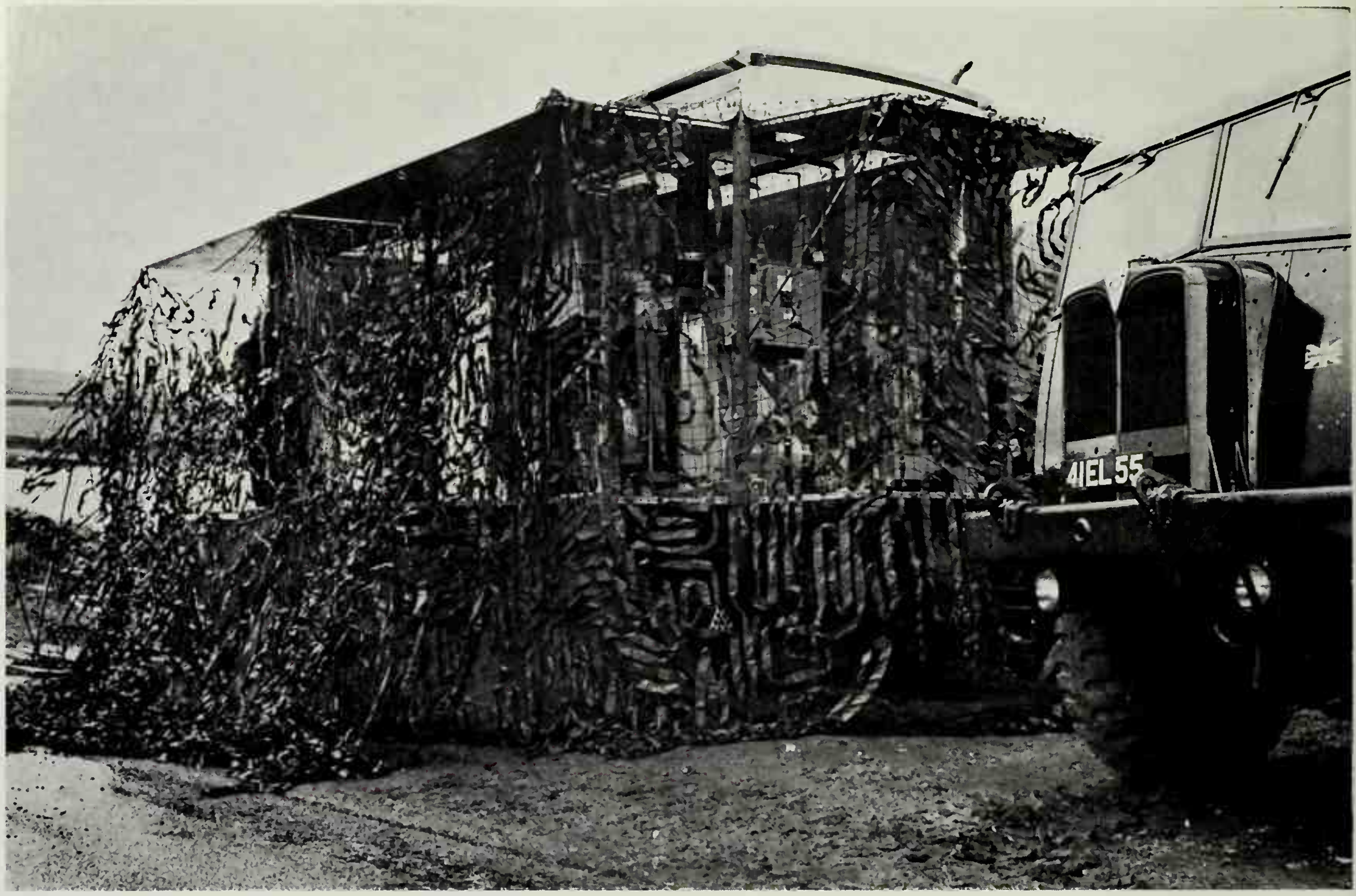
Zimmer walking aids and crutches inspire confidence and help re-train the disabled. They are constructed from durable aluminium tubing for strength and lightness.

Please write for illustrated literature.

Zimmer Orthopaedic Ltd
176/178 Brompton Road, London SW3 England
Telephone: 01-584 6416
Cables: Zimorpedic London SW3

Section 36

Field accommodation



Above: camouflaged Ibis mobile laundry unit

Right: one of the eight cubicles in an Ibis mobile shower unit

Left: interior of an Ibis mobile shower unit

Mobile laundry

and ancillary units

The Ibis mobile laundry unit is designed to provide laundry facilities for troops in the field, civil engineering sites, and disaster areas, and to supplement local resources wherever there is a temporary concentration of population. The equipment fits compactly into a strongly constructed trailer and includes all the machinery necessary for steam raising, water heating, laundry washing and drying. The trailer can be supplied with towing bar or as part of an articulated combine. The unit may also be used as a steam, hot water and power supply for ancillary mobile equipment, including shower units and bath houses.

The trailer carries its own fuel, sufficient for a ten-hour operational period and is dependent only on a suitable fresh water source being available. This may be any natural feature such as a river or lake, or a town supply. Steam is provided by an oil-fired boiler with a capacity of 318 kg of steam per hour from and at 100°C. This is used to supply hot water to the washing machine and steam to the heating batteries of the drying tumblers. A $16\frac{1}{4}$ kVA diesel ac generator provides electric power to drive the washing and drying machinery as well as supplying lighting, when required.

The laundry equipment consists of a 22-kg capacity end-loading washing machine, a 10-kg capacity hydro-extractor and two 10-kg capacity drying tumblers. This arrangement is capable of processing a total of 45 kg dry weight per hour, depending on the degree of soiling.

One side-wall of the trailer is divided longitudinally; the upper half can be swung outwards on site to form a canopy, while the bottom half can be swung down to rest on horizontal support beams to provide an extended working floor area. The rear bulkhead of the trailer is also divided in a similar manner.

The following units are also available:

1 A 90 kg/h capacity laundry unit. With this mode the generator is carried in the towing vehicle and can be skid-mounted.

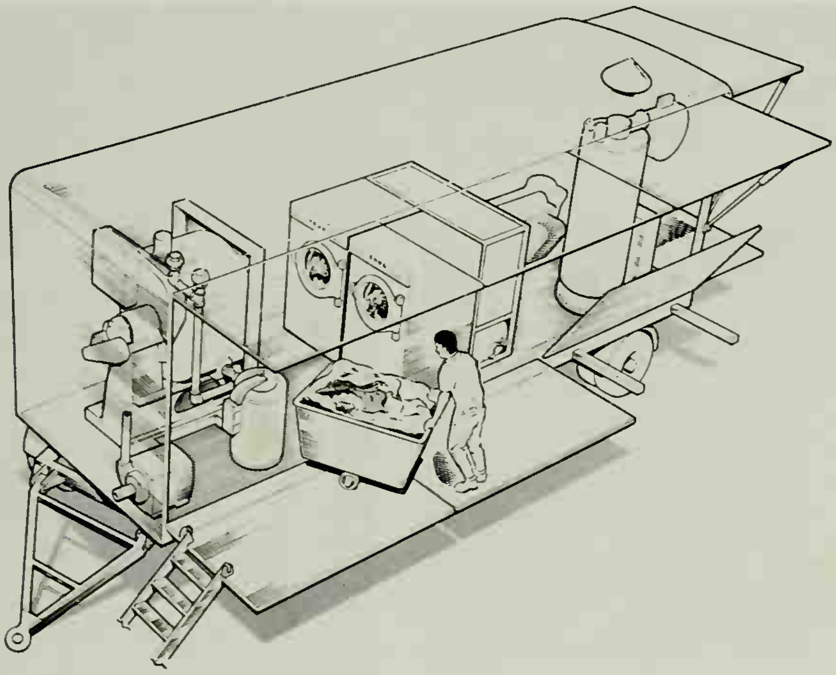
2 A mobile shower unit with the same overall dimensions and chassis as the laundry trailer. The shower unit includes eight changing/shower cubicles and is supplied from the laundry trailer with hot and cold water through a master mixing valve. The weight of the shower unit is less than 4570 kg.

3 All trailers can be supplied with towing bar or as part of an articulated vehicle.

Specification

The following basic specification is not mandatory and can be amended to suit the towing vehicle, conditions or special requirements.

Overall dimensions: height 3·5 m, length 8·375 m, width 2·29 m
Total weight: not exceeding 10 600 kg
Water supply required: 1818 litres per hour
Chassis: four-wheel, turntable-steered with towing bar. All-welded construction in high-yield steel. Tubular steel axles with taper roller-bearing hubs
Suspension: semi-elliptical, silico-manganese leaf springs. Stabilisers provided to block the springs during laundry operation
Wheels: five Sankey B6·5 HD × 20, 3-piece, 8-stud centre nave
Tyres: five 825 × 20, Dunlop, 14-ply rating
Brakes: S-cam type on both axles, pneumatically operated with armoured connecting hoses and palm type couplings. Parking brake operation by means of spring brake chambers
Boiler: diesel-oil-fired with a 318 kg/h steam capacity from and at 100°C
Generator: $16\frac{1}{4}$ kVA diesel engine-driven ac generator with all switch gear
Calorifier: 455 litre storage type with a 1360 litres/h output at 60°C
Washing machine: 22·6 kg dry weight capacity. Fitted with manual controls
Hydro-extractor: 10 kg dry weight capacity with a cylinder speed of 1425 rev/min and a $\frac{1}{2}$ hp motor
Drying tumblers: two 9 kg dry weight capacity. Steam-heated, with a $\frac{1}{2}$ hp motor
Fuel storage tank: 363 litres
Water pump: 7800 to 25 200 litres/h against heads of 12/2 metres respectively.
Fuel oil: gas-oil 34/45 secs Redwood No 1 at 100°F viscosity



Arrangement of Ibis mobile laundry unit, with walls swung open

IBIS ENGINEERS LIMITED
PO Box 23, Ibis Works, Shap Road, Kendal, Westmorland, England
Telephone: Kendal 22621 Cables: Ibis Kendal Telex Telex: 6580

Accommodation

mobile or permanent, plus furniture

Lesser International manufactures and supplies a number of prefabricated building systems to military establishments for all purposes, in all climates. Details of just two are given below. Furnishing and equipping can also be supplied, as part of the contract or separately.

Supalite
This system provides single or multi-storey buildings based on 1·22 m (4 ft) wide insulated panels. It is eminently suitable for officers' bungalows, messes, barrack blocks or amenity buildings. Supalite is long established and is backed by Lesser's considerable international experience. Basically intended for structures of a permanent nature Supalite buildings can, however, be re-located with a high degree of recoverability.

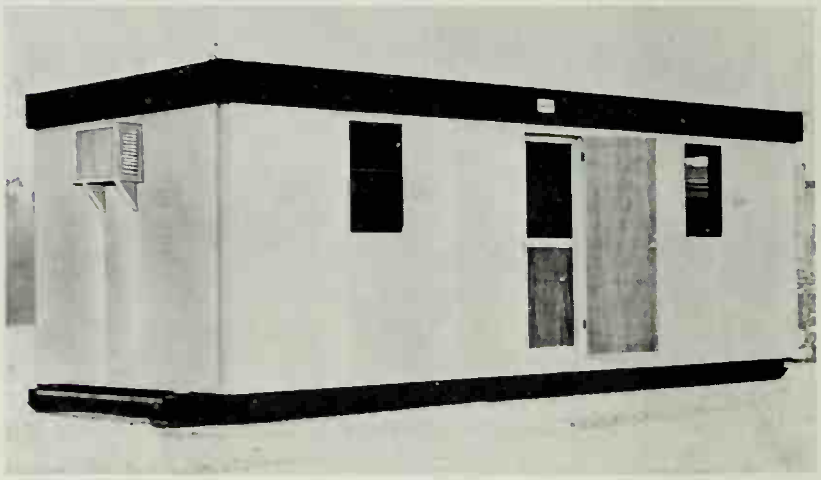
Among the many organisations specifying Supalite are the Defence Ministries of Muscat, Kuwait and Saudi Arabia.

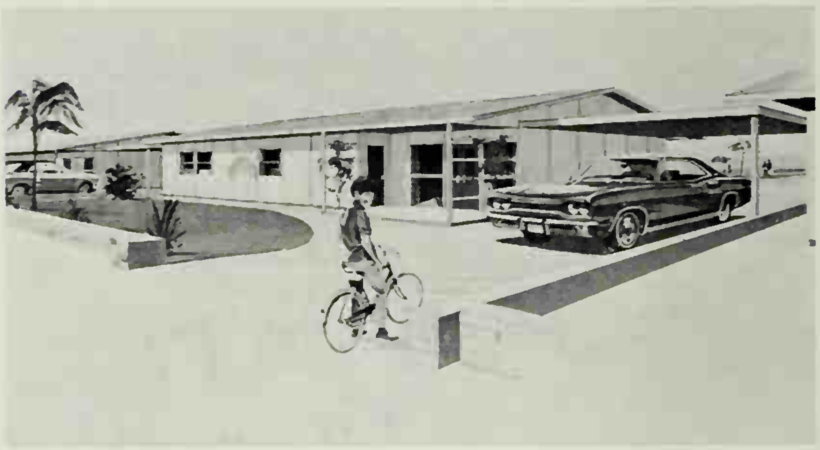
Supaskid
In contrast, Supaskid is a range of mobile units all with a steel-framed chassis and skid runners for towing short distances. Unlike caravans, Supaskid units can be carried flat for easy transportation on a low loader—up to three at a time—and can be joined to form larger buildings. They can also be supplied with wheels for towing medium distances. Supaskid needs no foundations and can be erected ready for use in a matter of hours. Ruggedly built and finished to very high standards, Supaskids are shipped with furniture and equipment for the knocked-down units stored in erected service units.

All Supaskid units are insulated and clad with aluminium. Air conditioning is generally supplied but the internal layouts and furnishing can be varied according to individual requirements. Standard sizes are 3 m (10 ft) wide by 7·3 m (24 ft) or 9·14 m (30 ft) long. By joining Supaskid units, buildings of 7·3 m (24 ft) or 9·14 m (30 ft) clear span and in any length in multiples of 3 m (10 ft) can be formed.

Furniture
Furnishing can be simple or luxurious and covers the whole range of requirements for kitchens, canteens, messes, offices, ablutions, barracks, libraries and bungalows. Most furniture and equipment can be supplied ex-stock delivered anywhere in the world.

Mobile base of Supaskid units


Self-contained air-conditioned Supaskid


Typical officers' quarters of Supalite construction

Barracks in course of construction

J E LESSER (INTERNATIONAL) LIMITED
JEL House, Staines Road, Hounslow, Middlesex, England
Telephone: 01-570 7755 Cables: Jell Hounslow Telex: 936161

Airportable cabins

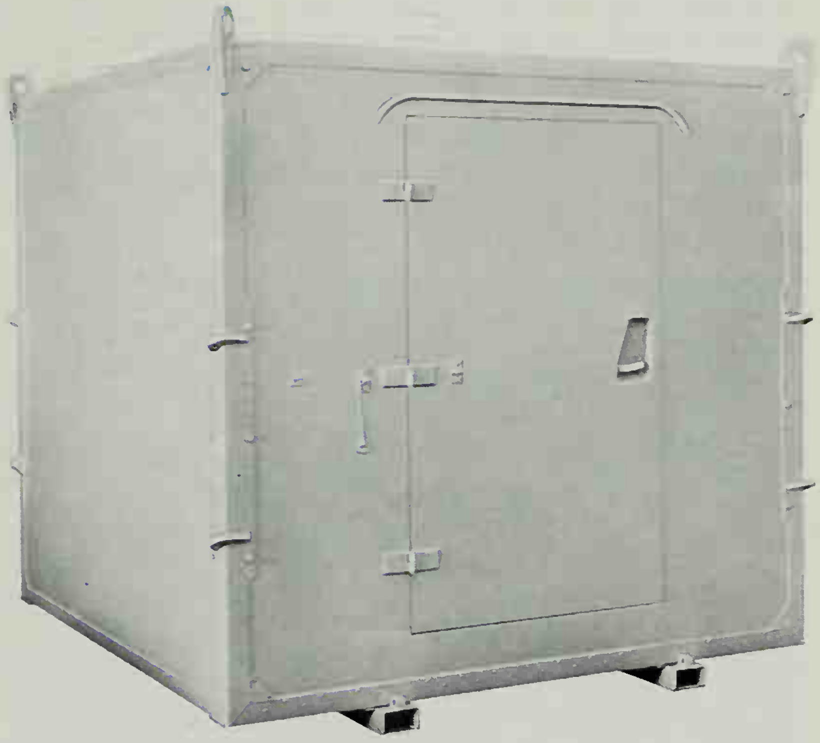
and trailer-type running gear

Aircon Type 616 cabin

The Aircon Type 616 is typical of the Airtech range of plastics cabins, all of which are designed to full military standards. The cabins are constructed from patented interlocking plastics sandwich panels bonded together into a light alloy reinforcing frame. Various panel thicknesses are utilised to give best possible payload/weight ratio coupled with very good thermal insulation. Top lifting points are a standard feature on all cabins (eliminating the need for sling spreaders); lashing points are provided on the corner members. The leading dimensions are as follows:

	Length		Width		Height	
	mm	in	mm	in	mm	in
Internal dimensions:	2381	93¾	2070	81½	1892	74½
External dimensions:	2565	101	2254	88¾	2184	86

Door opening size: 1651 × 902 mm (65 × 35½ in)
Weight: 468 kg (1040 lb)
Payload: 1361 kg (3000 lb)

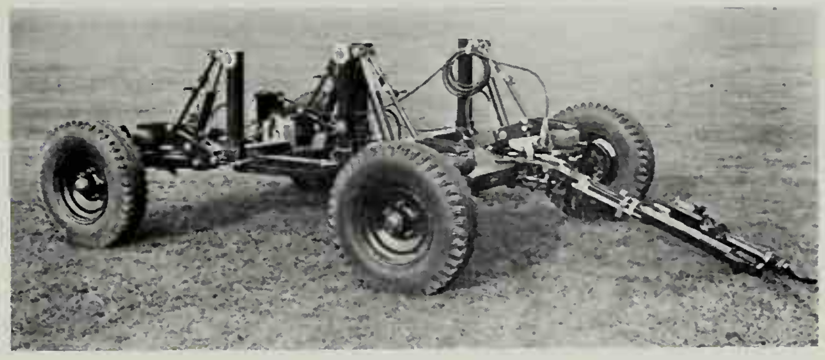


Aircon Type 616 cabin which can be lifted by helicopter and is suitable for transportation in Beverley, Belfast and C.130 aircraft

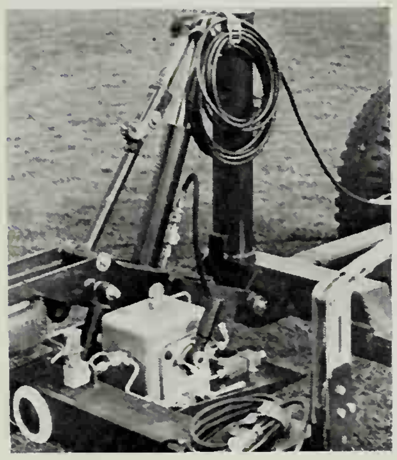
Airtech Mobilizer

Airtech Mobilizer running gears transform a container or pallet into a fully mobile trailer with cross-country capability. All Airtech cabins accept the Mobilizer in a matter of minutes with untrained personnel. The Mobilizer's built-in hydraulic jacking system enables the load to be picked up from ground level without the aid of any other equipment. Once raised the jacking system is locked out mechanically for added safety and the combined unit is ready for towing like a trailer. All Mobilizers have brakes on all four wheels and a parking brake on the rear wheels. Braking systems can be either overrun hydraulic surge or air over hydraulic. Ackerman steering is standard on all models. Full trailer lighting can be provided to meet customers' requirements. The following are the leading dimensions:

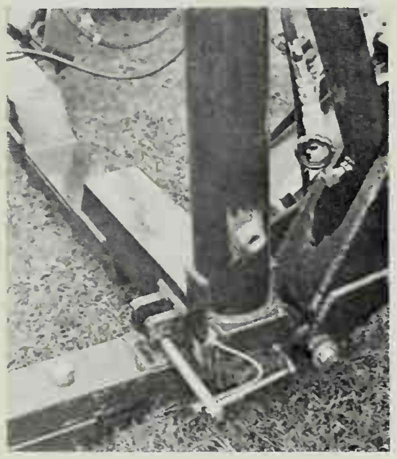
Payload: 2721 kg (6000 lb) full cross-country rating
Weight: 830 kg (1830 lb)
Max road speed: 64 km/h (40 mph)
Max. cross-country speed: 24 km/h (15 mph)
Suspension: air bag with independent hydraulic shock absorbers
Overall width: 2409 mm (98 in)
Overall length (close-coupled with tow bar stowed): 3200 mm (126 in)
Ground clearance: 380 mm (15 in) minimum



General view of unladen close-coupled Type A.6000 Mobilizer



Integral hydraulic lifting system and parking brake



Payload location tines and attachment retaining pin

Details of other cabins and mobilizers are available on request.

AIRTECH LIMITED
Haddenham, Aylesbury, Buckinghamshire, England
Telephone: Haddenham 422   Cables: Airtech Haddenham   Telex: 83223

AIRTECH

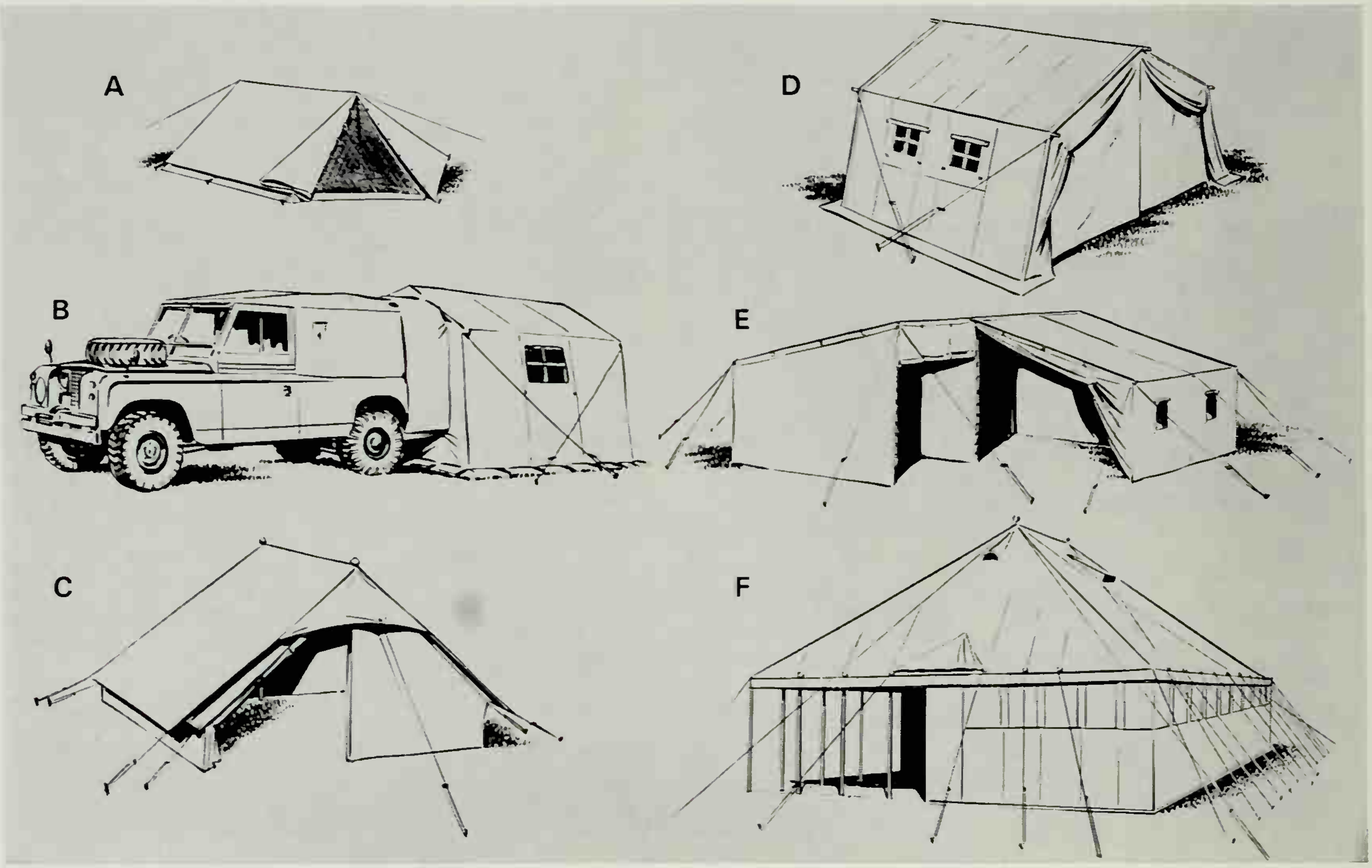
Tents

for personnel and equipment

In addition to the very wide range of modern tents and portable shelters to strict contract specifications, the Black & Edgington group produces a comprehensive variety of textile equipment for the armed services.

An active Product Development Department is available for advice and for the preparation of prototype specialist field equipment to suit particular overseas requirements.

Ancillary equipment produced by the group includes safari military camp beds with or without nets, wood or metal camp and barrack folding furniture, officer's camp kits, ponchos and groundsheets, banderol beacons, flags and regimental colours, combat sleeping bags and a wide range of specialised high-performance synthetic and downfilled bags.



ome typical tents as briefly specified below. A comprehensive catalogue is available on request

Specifications

A
Bivouac tent, mosquito and sandfly-proof
Catalogue numbers JA5717/JA5718
Standard two-man shelters, fitted net curtains each end and sand pockets all round. Length 3·20 m including 1·06 m triangular extension, width 1·90 m, weight 5 kg

B
Command post shelter, general-purpose, Mk 2
Vocab J1/8340-99-135-1424
Lightweight tubular frame shelter used either as free-standing unit or with Land Rover. Length 2·67 m, width 2·85 m, height at eaves 1·58 m, height at ridge 2·03 m, weight 39 kg

C
Tent, general service, Mk 2
Vocab J1/8340/99/942/4584
Tent with outer fly having fitted hoods each end to protect entrances. Dimensions 4·27 × 4·27 × 2·20 m high, walls 0·75 m. Also Vocab J1/8340/99/942/4583 similar tent but dimensions 4·27 × 2·45 × 2·20 m high, walls 0·75 m

D
Lightweight portable shelter
Vocab J1/8340/99/120/6736
Mobile high-wall accommodation. Rigid self-supporting frame, extendable by 3·65 m units. Basic shelter 4·57 × 3·65 × 2·7 m high, weight 100 kg. Packs on Land Rover or ½ ton trailer. Inner insulating linings for basic shelter and extension units

E
Portable shelter assembly F
Vocab J1/JA 8521
Tubular framework with canvas covering, two double-bays each 6·1 × 5·5 m and one single bay 3·05 × 2·75 m, each bay 2·60 m high at front and 1·83 m high at rear. Also assemblies (A) J1/JA13260 1: single bay, (B) J1/JA13265 1: double-bay, (C) J1/JA8518 2: single bays, (D) J1/JA8520 3: single bays, (E) J1/JA8536 4: double bays

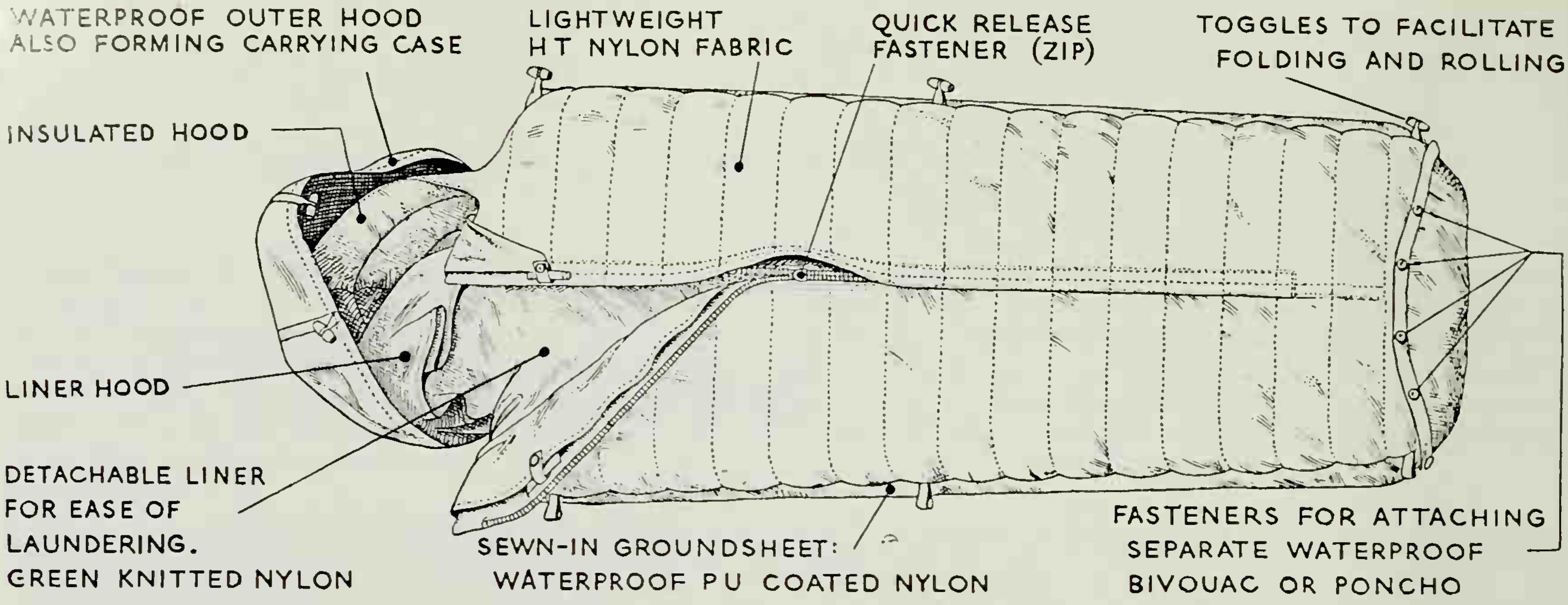
F
Universal marquee tent
Vocab J1/8340/99-942-4589 etc
Standard width 6 m and extendable from 5·50 × 6 m by additional standard sections of 2·75 m to any length both single and double-roof. Typical sizes, general-service single and double-roof 8·25 × 6 m. Operating double-roof 5·50 × 6 m. Hospital double roof 11·00 × 6 m. Store single roof 13·75 × 6 m. All with standardised walls 1·65 m high

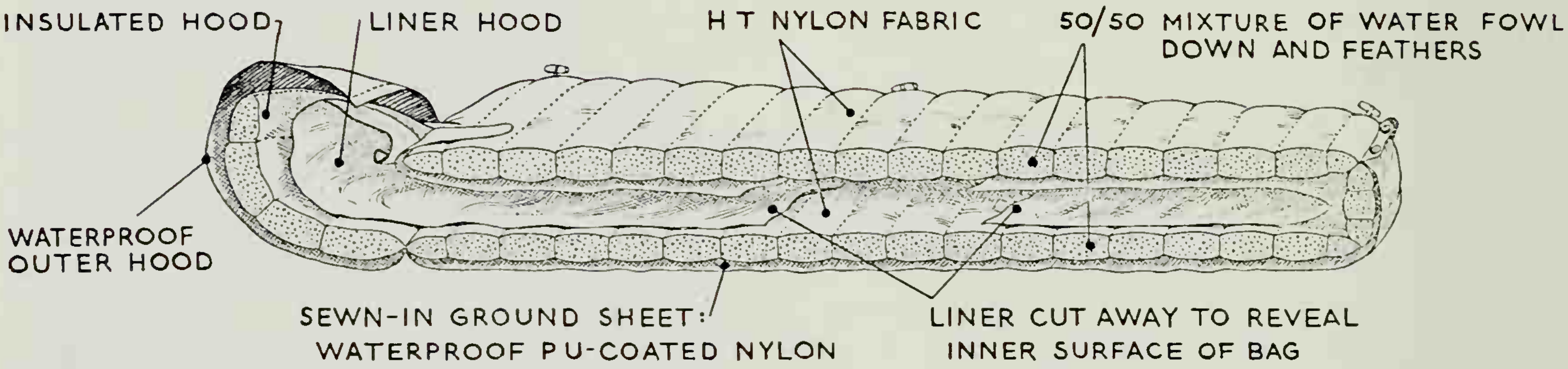
BLACK & EDGINGTON LIMITED
Ruxley Corner Works, Sidcup, Kent, England.
Telephone: 01-302 0211 Cables: Benedge Sidcup Telex: 897371

By Appointment to
HM The Queen
Tent and Flag Makers
Black & Edgington Ltd

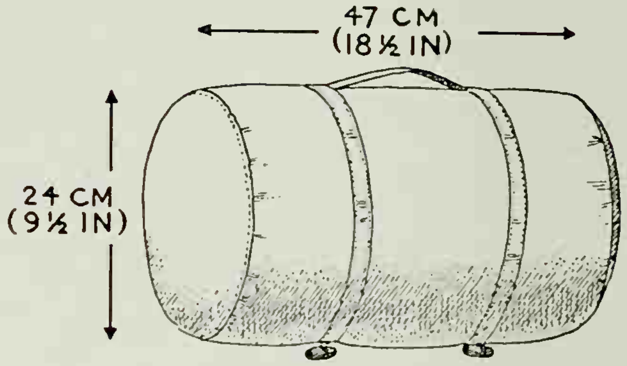
Section 37

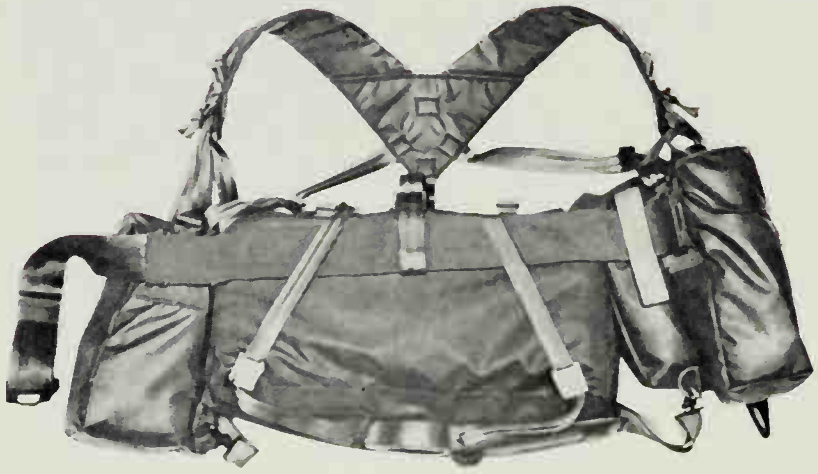
Uniforms and personal equipment


WATERPROOF OUTER HOOD ALSO FORMING CARRYING CASE
LIGHTWEIGHT H T NYLON FABRIC
QUICK RELEASE FASTENER (ZIP)
TOGGLES TO FACILITATE FOLDING AND ROLLING
INSULATED HOOD
LINER HOOD
DETACHABLE LINER FOR EASE OF LAUNDERING. GREEN KNITTED NYLON
SEWN-IN GROUNDSHEET: WATERPROOF PU COATED NYLON
FASTENERS FOR ATTACHING SEPARATE WATERPROOF BIVOUAC OR PONCHO

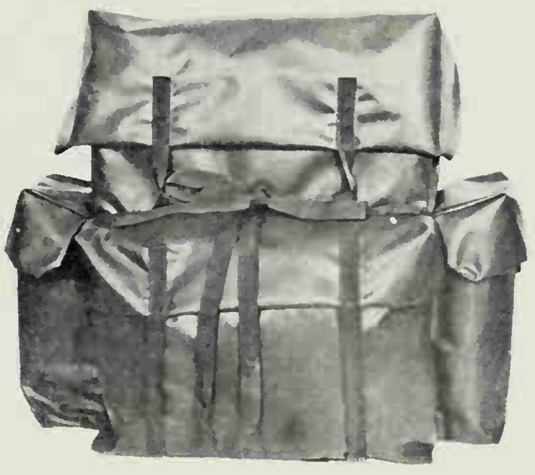

INSULATED HOOD
LINER HOOD
H T NYLON FABRIC
50/50 MIXTURE OF WATER FOWL DOWN AND FEATHERS
WATERPROOF OUTER HOOD
SEWN-IN GROUND SHEET: WATERPROOF PU-COATED NYLON
LINER CUT AWAY TO REVEAL INNER SURFACE OF BAG

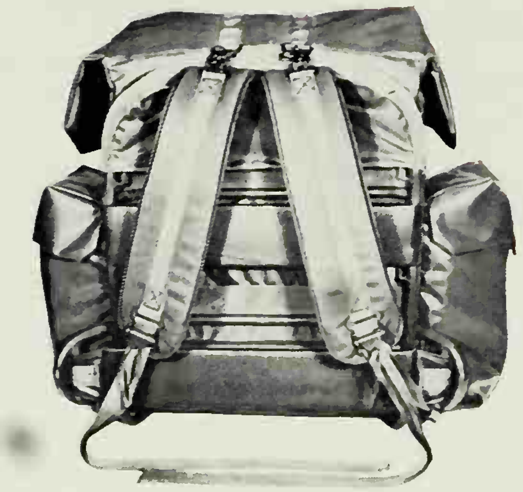
Top: Diagram showing the various parts of the sleeping bag. Above: Section showing its construction. Right: Rolled up like this, the sleeping bag is carried on top of the rucksack

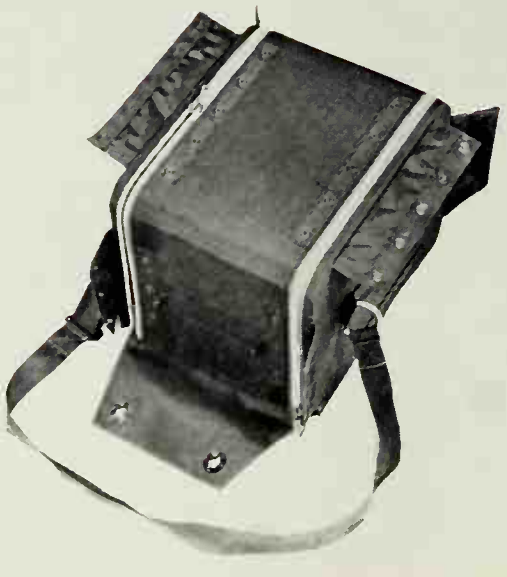

47 CM (18½ IN)
24 CM (9½ IN)



Left: Fighting order load-carrying harness. Below left and centre: Front and rear view of the rucksack; the rear view shows the carrying frame. Below right: Special carrying case for guided missile control unit







Personal equipment

for military and civil forces

Originating in the 1930s as part of another organisation, the experience gained in World War 2 of service requirements was further broadened by the Chelsea Quilt Company during the Korean War when it became a main contractor to the British Ministry of Defence.

Since then the company has held substantial Ministry of Defence and foreign government contracts and has built up a reputation for quality and prompt delivery.

The Chelsea Quilt research and development section co-operates closely with British and overseas development establishments to develop the precise type of equipment required.

A new modern factory at Barnstaple is well equipped and has substantial production capacity to deal with main contracts to the highest standards of inspection.

Products currently include personal equipment, field sleeping gear, carrying cases and specialised protective outerwear for the British Ministry of Defence and foreign governments. Tenders from foreign governments are invited.

Sleeping bag for combat and general service

This bag is designed as a lightweight sleeping bag capable of rolling up to a small bulk for carriage on the man, and incorporates a quick-exit capability. It has been in service with the British Army since 1964.

The outer material is a lightweight heat-calendered nylon fabric, and the insulating material is a 50 percent waterfowl down and 50 percent waterfowl feather mixture. A polyurethane-coated nylon fabric is used for the sewn-in groundsheet and outer hood. To maintain ventilation, the outer material is not waterproof, and when used in the open it is intended that it be used in conjunction with a poncho or bivouac sheet. There is a nylon quick-release slide fastener fitted for rapid exit. When rolled up, the sleeping bag fits into the outer hood and is secured by toggles and loops. The bag is available in two sizes: normal and long.

A detachable easily laundered and quick-drying liner manufactured from nylon fabric is provided with the sleeping bag, and is fitted to the bag by means of nylon tapes and press fasteners. The weight of the bag is about 2·7 kg (6 lb).

Personal load-carrying equipment

The 'Fighting Order' load-carrying equipment is made to Ministry of Defence specifications. It enables the soldier to carry his minimum needs for combat and to perform his duties with maximum efficiency in temperate, tropical and cold weather environments. It comprises waist belt, yoke, ammunition pouches (right and left), water bottle carrier and haversack. (Other configurations can be supplied.)

The use of nylon webbings and coated nylon fabric has reduced overall weight by almost 50% compared with cotton webbing equipment at present in service.

The pouches, haversacks and water bottle carriers are all waterproof. The synthetic webbings absorb little or no water and make the equipment equally efficient in either wet or dry conditions.

Rucksack

The rucksack shown is to Ministry of Defence specification and is intended as a lightweight replacement for present rucksacks used on special operations. It is also intended to replace existing main packs carried by the combat soldier in the marching or existence role. It is manufactured of coated nylon fabric; nylon webbing is used for all the straps and ties. Three pouches are sewn on the outside to provide quick access to priority items. The rucksack can be carried with or without a manpack frame; when the frame is worn the top of it fits into a pocket on the rucksack and is secured at the base with nylon straps.

Special carrying cases

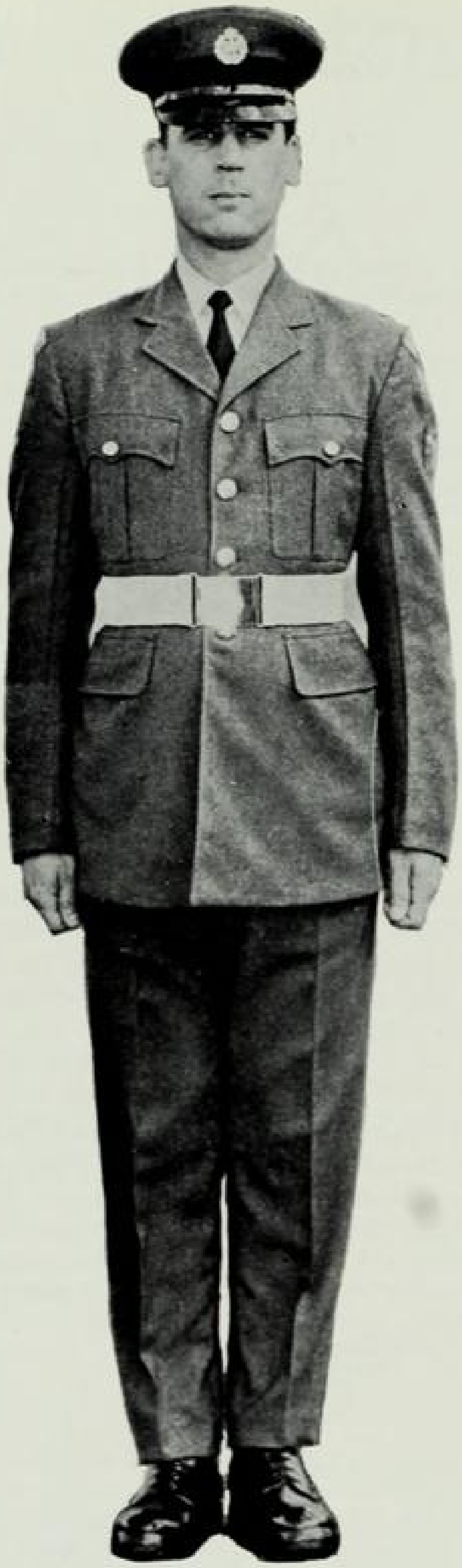
In addition to the normal combat load, the modern infantryman is required to carry certain specialist items of equipment. The research and development section of the company is experienced in producing both for the Ministry of Defence and for industry efficient carrying cases for all types of equipment. These include radio and associated equipment, support weapons, ammunition, and optical equipment, etc. They can be manufactured to individual customer requirements.

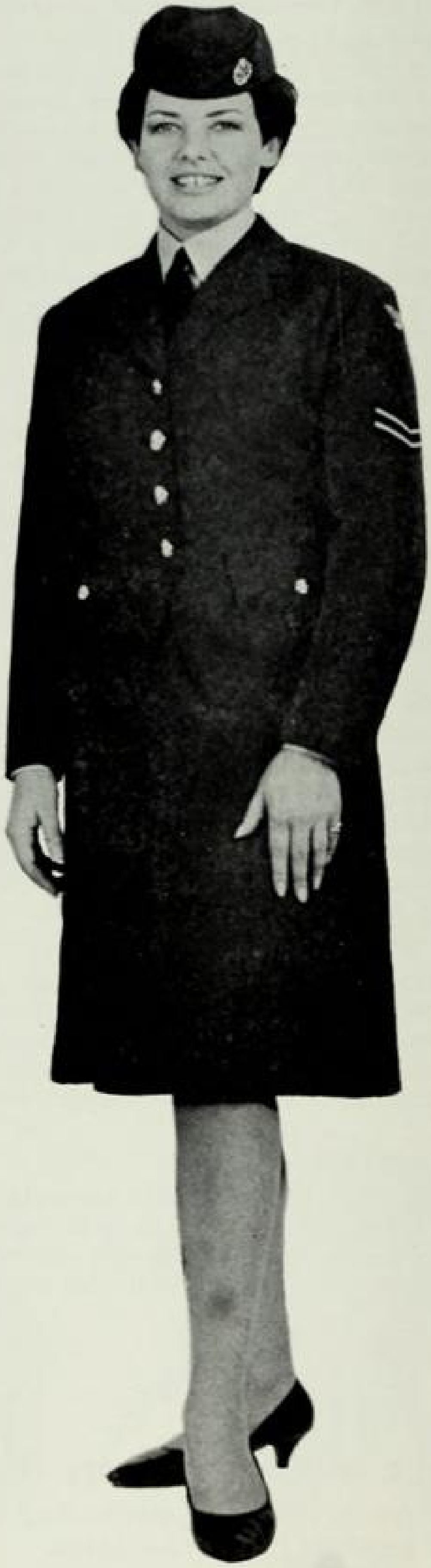
Other products

The introduction of lightweight synthetic fabrics and webbings has proved so successful under all climatic conditions that the company is now engaged in the manufacture of valises, lightweight shelters, gun covers, vehicle tilts, paulins, hand luggage, quilted protective covers, collapsible water containers and similar items for many military, para-military and civil organisations in many parts of the world.

CHELSEA QUILT COMPANY LIMITED
Riverside Works, Barnstaple, Devon, England
Telephone: Barnstaple 72345 Telex: 46106

CQC





Serving members' uniforms for the Royal Air Force (above) and Women's Royal Air Force (right) supplied by H Edgard & Sons (London) Ltd

Uniforms

for all services

The Edgard family tailoring business, which was founded in 1850, built up a reputation for high-class London tailoring including the tailoring of uniforms.

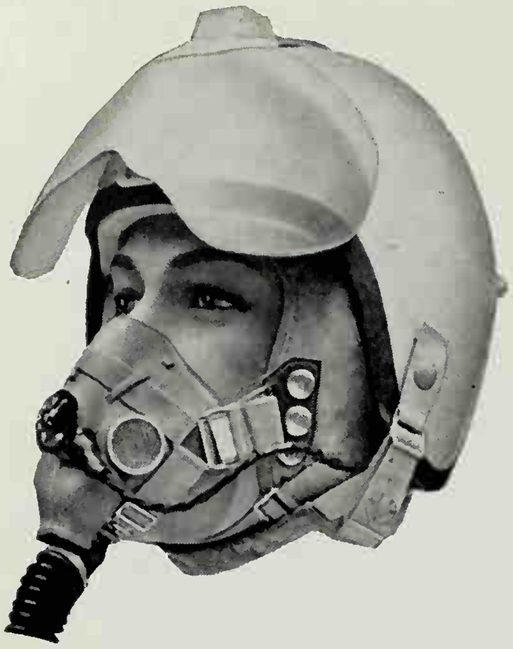
During World War II, to ensure uninterrupted production, a new modern factory was opened at Whitehaven in Cumberland, where upwards of 75 000 high-quality uniforms are now produced each year under contracts awarded after tender by the British Government.

Today we can proudly claim that members in the ranks of the Royal Navy, the Army and the Royal Air Force—both men and women—who are issued with uniforms made by H Edgard & Sons (London) Ltd, at their Whitehaven factory wear what is virtually a Savile Row uniform unrivalled for quality.

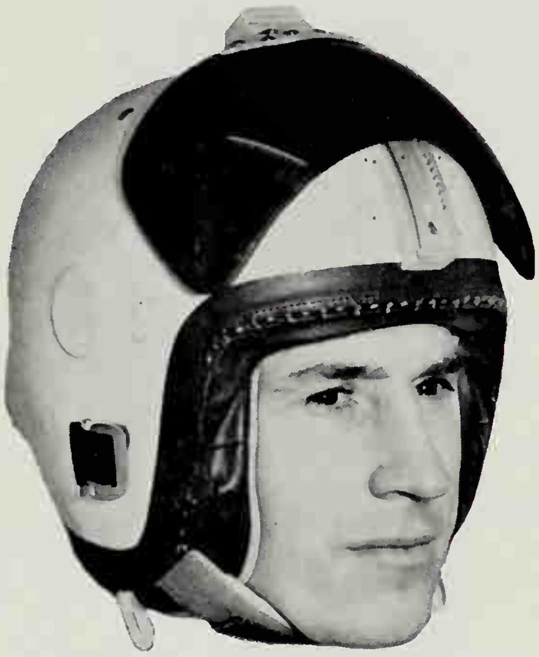
Tenders from foreign Governments are invited.

H EDGARD & SONS (LONDON) LTD
PO Box 22, Whitehaven, Cumberland, England
Telephone: Whitehaven 2441

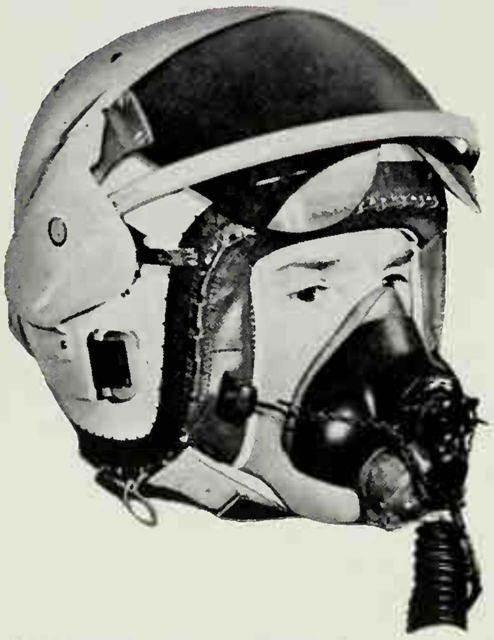
Edgard Products
GARMENTS OF DISTINCTION



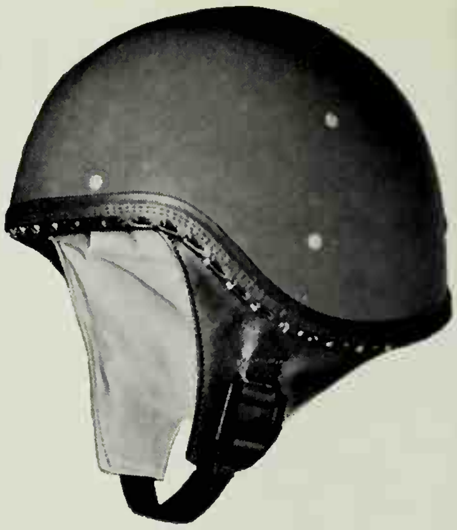
The Mk 1A flying helmet which is particularly popular with air forces using British-built aircraft (RAF ref. 22C/1253074-1253088)



The Mk 3A flying helmet for use in helicopters and other fixed-seat aircraft not provided with oxygen equipment. The Mk 3B is identical except that it is fitted with attachments for an oxygen mask

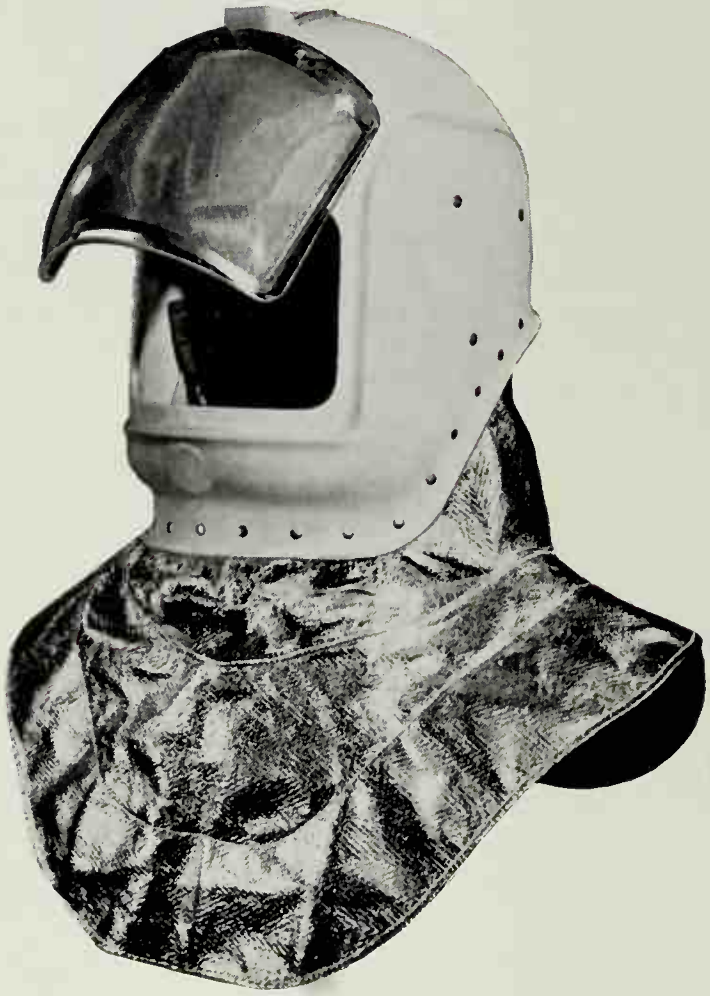


The Mk 2A flying helmet is similar to the Mk 3B but is fitted with automatic visor for use in high-speed aircraft equipped with ejector seats and provides full protection under severe blast conditions. Each of these helmets is designed to be comfortable in wear over long periods



The parachute instructor's helmet made to specification DTD 1258, is produced in 11 sizes (RAF ref. 22C/1253062-1253073)

Mk 2A RAF ref. 22C/1253128-1253130
Mk 3A RAF ref. 22C/2565-2567
Mk 3B RAF ref. 22C/2568-2570



The fire protection helmet for airfield fire-fighting personnel is fitted with an adjustable, removable head harness. The sliding visor is easily adjusted with the finger and thumb of one gloved hand, and the flameproof aluminised asbestos curtain gives added protection to neck, chest and shoulders (RAF ref. 22G/1920)

Helmets

flying, parachute instructor's and fire protection

For over 40 years Helmets Ltd has devoted its ample scientific resources to the study and development of protective equipment. This experience is built into all the items shown here. They are the result of intensive research and have been proven in use in many parts of the world—and in all conditions.

Mk 1A flying helmet

This is used throughout the world by air forces with British-built aircraft. The helmet is worn with an inner helmet (Type 'G'), which carries sound-absorbing telephone capsules and attachments for an oxygen mask. The Mk 1A helmet is available in five sizes, each with three fittings. The type 'G' helmet is made in four sizes. The telephone receivers (Ref 10AH/19) are normally fitted wired in parallel (cable harness Ref 10HA/13158) to give an impedance of 150Ω. An alternative series-wired harness can be supplied to give an impedance of 600Ω. These harnesses terminate with a NATO plug (Ref 10H/9466652). Extension cords are available for use in fixed-seat aircraft.

Anti-glare visor

The anti-glare visor fitted to the Mk 1A helmet comprises a centre rail attachment and mechanism (Ref 22C/1646–7) and a replaceable neutral-tinted acrylic anti-glare screen which is available in two densities of tint: light tint 25–30 per cent transmission (Ref 22C/1648–9) and dark tint 12–15 per cent transmission (Ref 22C/1650–51). The latter is fitted unless otherwise specified. The visor screen has a straight lower edge which permits a clear view of the instruments. If more blast protection is required, an alternative visor screen (Mk 2B) should be specified, where the lower edge is shaped to fit closer to the face. The standard shape of screen is illustrated on the Mk 3A helmet and the modified Mk 2B shape is illustrated on the Mk 1A helmet.

Mk 3A flying helmet

This helmet is for use by aircrew regularly concerned with low-altitude aircraft (including rotary wing aircraft) not provided with oxygen equipment. It embodies the centre rail attachment anti-glare visor with replaceable acrylic screen and carrying mechanism exactly as fitted on the Mk 1A helmet. The telephone equipment has particularly good signal-to-noise ratio with minimum size and weight. A single miniature telephone of 300Ω impedance feeds the signal via sounds tubes to acoustically designed ear capsules with fluid seals. The helmet is designed for use with hand, boom, or throat microphones. It is made in three sizes, each with all the necessary adjustments for exact individual fitting.

Mk 3B flying helmet

This helmet is identical with the Mk 3A, except that it is fitted with attachments for oxygen masks type P or Q.

Mk 2A flying helmet

This is similar to the Mk 3B but is fitted with an anti-glare/anti-blast visor designed for both manual and automatic operation. An acrylic screen forms both a blast and an anti-glare visor. Manual operation is by a side-pivoted semicircular bar which moves the screen into any selected position, the bar springing back on release to its starting position. The bar is so arranged that it is moved by the descent of the blind on ejection. Under ejection 'g' forces, the screen is locked down automatically. The standard telephone cable assembly terminates in a short central pigtail and a NATO-type plug (Ref 10H/9466652). The microphone plug is low down on the left cheek and accepts the standard socket (Ref 10H/14207); alternative wiring terminating in PL55 and PL68 plugs can be supplied. Helmets of the Mk 2 and Mk 3 series are supplied complete with stowage cases.

Parachute instructor's helmet

The outer shell is of moulded glass-fibre resinate, provided with a shock-absorbing lining and a nylon webbing cradle to minimise transmission of shock forces to the head and to distribute them over as large an area as possible. Provision is made for the outer layer of the necklet to be attached to the edge of the shell, to provide a smooth contour and to eliminate the possibility of snagging by the parachute cords.

Fire protection helmet

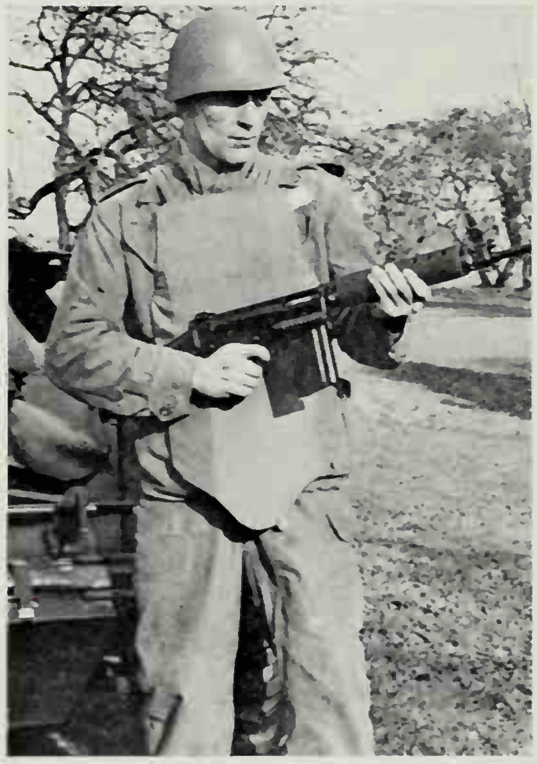
This helmet is designed as a fire proximity helmet providing complete protection for a minimum of three minutes when used in conjunction with the appropriate clothing.

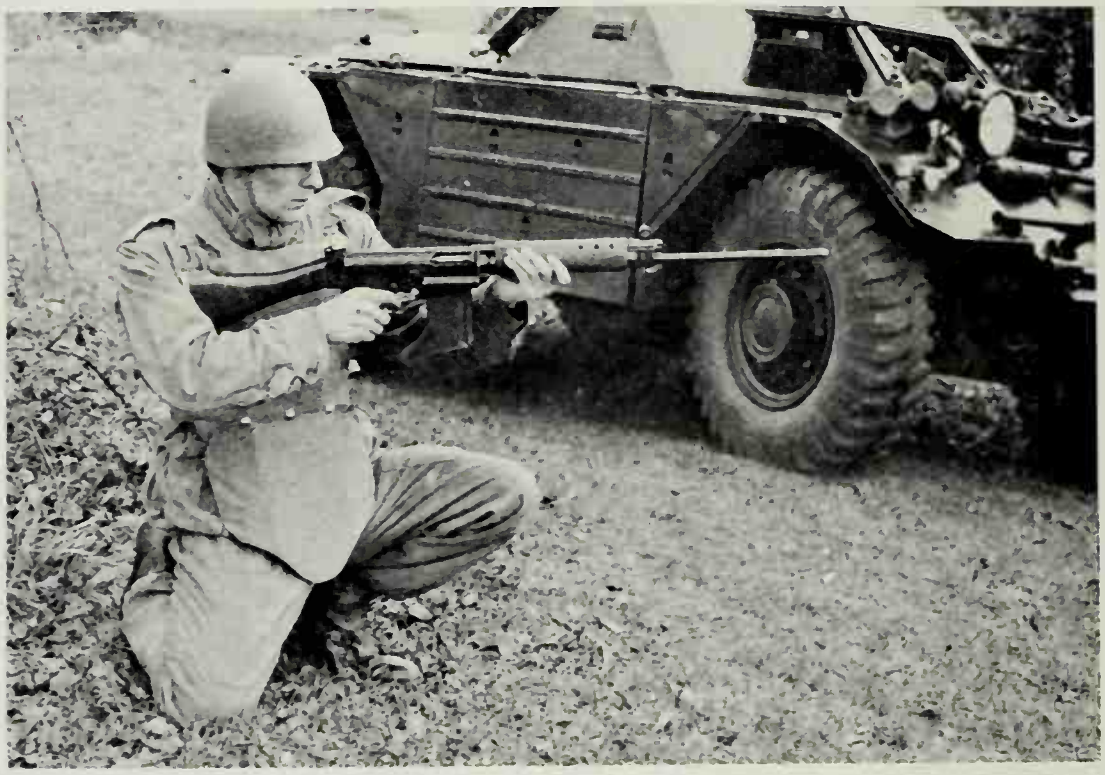
HELMETS LIMITED
Wheathampstead, St Albans, Hertfordshire, England
Telephone: Wheathampstead 2221

Lightweight body armour

for infantry and security forces

A reinforced plastics composite provides a lightweight armour for protecting infantry and security forces against small-arms fire. The armour is designed to permit the wearer to perform his duties with the minimum of restriction under all conditions. To provide additional comfort in wearing and to minimise the shock of impact to the body, a resilient lining is bonded to the inside face of each panel.


Complete upper torso armour with pelvic protection. Similar armour can be provided for the back. The pelvic armour is detachable.


Weighing little more than 5 kg (11 lb), full torso armour can be worn without discomfort and minimal hindrance to all normal duties. The armour is held securely in place by adjustable straps; it can be put on and discarded in a matter of minutes, without help tools or special training

Weights

Full front (with detachable pelvic panel): 3·13 kg (6·876 lb)
Upper torso only: 2·0 kg (4·45 lb)
Front and back (upper torso only): 4·03 kg (8·88 lb)
Complete upper torso with pelvic protection: 5·145 kg (11·326 lb)

Helmet

A lightweight helmet is now available weighing only 0·71 kg (25 oz) and offering protection against small-arms fire. Although not designed to meet the same threat as the body armour, the helmet is manufactured from the same materials, is lighter than a steel helmet and gives superior protection.

This reinforced composite plastics helmet is much lighter than a steel helmet, yet offers superior protection against small arms fire and impact

Performance

The body armour will stop and contain multi-hit threats from the following weapons, fired from the range (in metres) shown against each weapon:

		Metres
7·62 mm Mauser (·30 cal)	Automatic	2·74
9 mm M.39 round	Automatic	7·32
9 mm MAC	Automatic	3·66
9 mm SL/MG MAT 49	Automatic	1·83
9 mm Luger Parabellum	Automatic	2·74
Walther PI	Automatic	1·83
9 mm Browning Herstal'	—	1·83
·357 Colt	Revolver-Magnum	9·14
·38 Enfield	Revolver	2·74
·38 Special	—	3·66
·38 Winchester	Revolver-Magnum	3·66
·44 Ruger-7½-inch barrel	Revolver-Magnum	2·74
·45 Colt	Automatic	2·74
7·62 Avtomat/Kalashnikov	Combat light machine gun	15·24
9 mm UZI	Light machine gun	3·66
12-bore Shotgun FN	2½ inch × No 6 shot both barrels	2·74
12-bore Federal	25/12G BB shot	3·66
12-bore Remington	9-shot BB shot	3·66

ROLLS
ROYCE

ROLLS-ROYCE (COMPOSITE MATERIALS) LTD
Avonmouth Road, Avonmouth, Bristol, BS11 9DU, England
Telephone: Avonmouth 4821 Cables: Rolcom Avonmouth Telex: 44207

Rubber compounds for service footwear

Avon specialises in the development of rubber compounds for use in the manufacture of footwear for the armed services.

Avon also manufactures complete rubber footwear, including safety boots with internal steel toe-cap, as well as other protective footwear.

Avon Footwear Ltd
Bridgend, Glamorgan, South Wales

Telephone: Bridgend 3211
Cables: Rubber Bridgend
Telex: 44142

Rucksacks, haversacks, manpack frames

A range of about 50 standard types of rucksacks, haversacks and carrying-frames are in constant production, with design and development capacity to undertake projects of a special nature.

Rucksacks made by Brown Best (the oldest specialist rucksack manufacturer in the UK) are in current use by units of the British armed services, including the Royal Marines.

Brown Best rucksacks were used on the successful ascent of Everest and on numerous other expeditions all over the world and have always been most highly regarded for their careful design and high standard of both materials and workmanship.

Natural and synthetic materials are available in khaki, jungle green, sand, white or camouflage, with frames in steel or alloy tube.

Brown Best & Co Ltd
102 Old Kent Road, London SE1, England

Telephone: 01-703 8111
Cables: Abri London SE1

Cloth for uniforms of all kinds

We are the manufacturers of the widest range of cloths in the UK to meet the requirements of the armed services, police, fire and similar forces.

All types of woollen, worsted and blended cloths are available, all in a wide range of colours, weights and qualities. Special cloths for tropical wear, ceremonial wear and for various kinds of protective clothing can also be supplied.

In addition, we also manufacture cloths for caps, helmets and other items of apparel, as well as trimming cloths and similar accessories.

We also operate an advisory service based on many years of experience in the field of military clothing. To meet special requirements for specific uses and special-purpose uniforms, the services of a development department are available.

A W Hainsworth & Sons Ltd
Spring Valley Mills, Farsley, Pudsey, Yorkshire, England

Telephone: Pudsey 3091
Cables: Army Pudsey

Section 38

Advisory and supporting services

Airwork Services Ltd, a member of the Air Holdings Group, one of the largest independent aviation groups in the world, has for many years provided a very wide range of support services and training facilities for a large number of defence forces and civil authorities in many parts of the world.

Role

The major role of the company is the provision of specialist qualified manpower to meet the needs of both military and civil organisations for training, operation, technical support and management of modern technical equipment. Specialist support in the following fields can be provided.

Consultancy

Complete surveys, evaluation of systems and equipment and the creation of supporting repair and maintenance organisations can be undertaken for a wide range of equipment. Advice can be given on the size and equipment of workshops, schools and buildings for special requirements; technical specifications for buildings can be provided.

In addition to setting up repair and maintenance organisations for customers, technical training schemes for overseas clients within their own countries can also be prepared.

Technical and flying training

We can organise and set up technical training establishments in overseas countries, providing instructors and staff, training aids, equipment and text books. We can prepare syllabi and ensure the maintenance of training standards. We can also advise on the size of buildings, classrooms, laboratories and training workshops.

Complete training services in aviation and air defence subjects can be made available. Airwork Services Training of Perth in Scotland, established for over 30 years, provides flying and aeronautical engineering training.

Aircraft services

Provision of operational and maintenance staff including military and civil pilots, navigators and signallers. Engineers and technicians for the maintenance of airframes, engines, instrumentation, electrical, electronics and hydraulics, armament and safety equipment. Specialist personnel are available for base workshops and associated support services.

Airfield services

Qualified personnel are available for the operation and maintenance of air traffic control systems, surveillance radar, communication systems, navigational aids, airfield approach aids, including ground control approach, precision approach radar, and instrument landing systems, as well as fire, crash and rescue services.

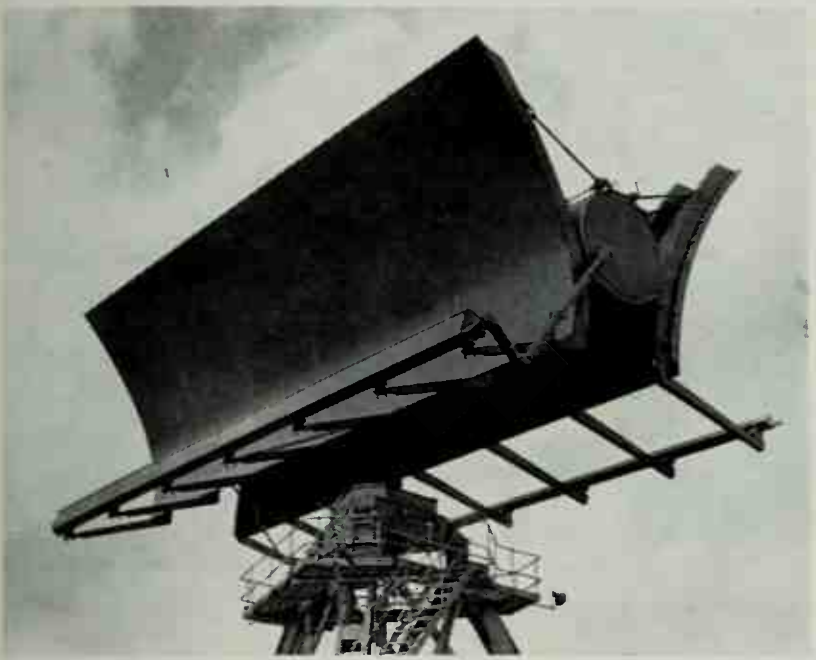
Supplies and stores

The company undertakes full responsibility for the setting up, organisation and day-to-day running of a complete stores and supply service; evaluation of spares;

purchase and delivery of aircraft, radar, engines and components; packaging and despatch of equipment and stores by sea or air, including long-range ferrying of aircraft.

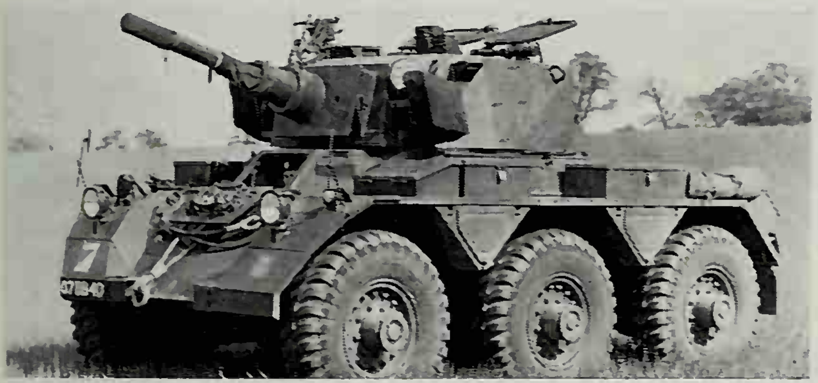
Technical support

and advice for military and civil authorities



Weapon systems

Services for the following can be made available:
surface-to-air guided weapon systems;
air-to-air guided missiles;
air-to-ground guided missiles;
ground-to-ground missiles.
Supporting services for the above, including:
special handling and storage requirements;
assembly and testing of missiles;
on-site test and repair;
base workshop test and repair.



Vehicles

We can provide maintenance and repair facilities for all types of vehicles, including armoured fighting vehicles, logistic vehicles, earth-moving equipment and specialist vehicles. Complete technical support including training, field and base workshop facilities can be provided.

Marine craft

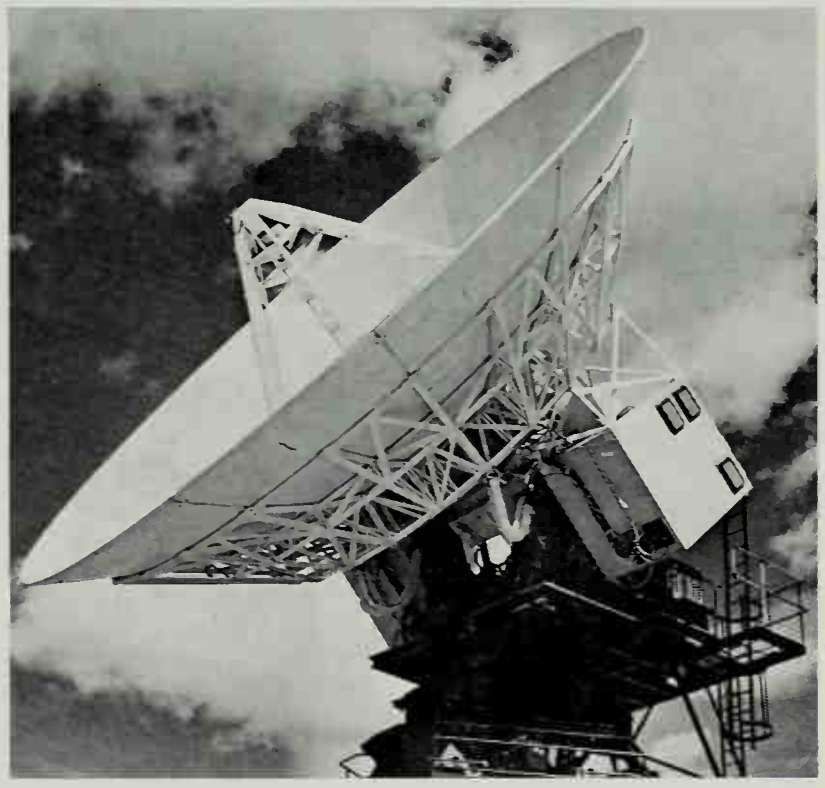
We can undertake maintenance and overhaul of propulsion and auxiliary equipment, navigation and depth-sounding equipment.

Radar

Operation and maintenance personnel are available for:
military and civil surveillance radar;
air defence control and reporting systems;
auto-tracking radar; weapon system radar;
satellite tracking and trainers;
radar test and repair facilities, including test calibration.

Communications

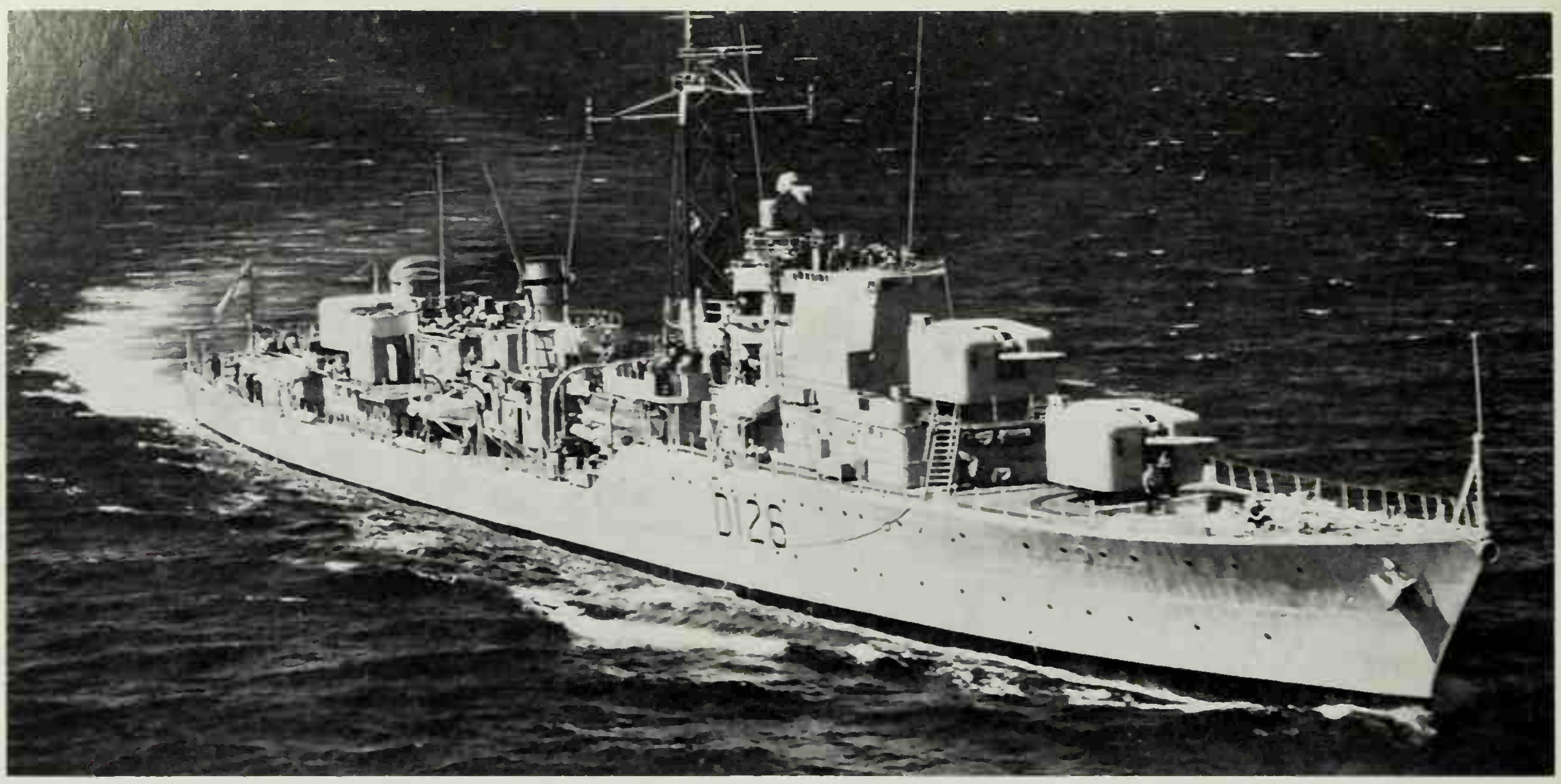
Specialists can be provided for operation and maintenance of:
air defence control and reporting networks;
tropospheric scatter systems;
radio relay systems in the VHF, UHF and SHF bands; mobile radio stations;
digital data links, including computers, coding, decoding and data storage equipment;
supporting test and calibration facilities.



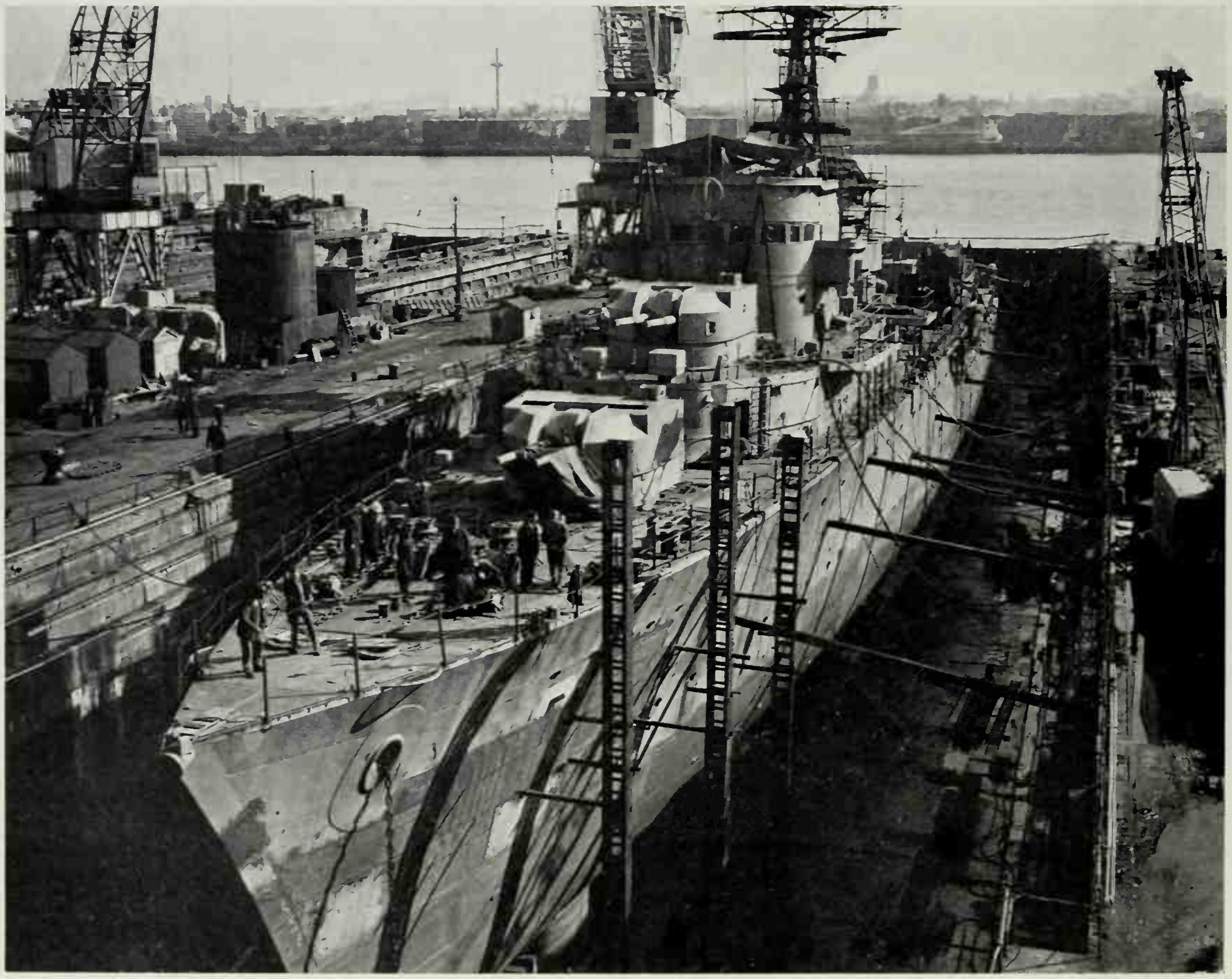
A member of the Air Holdings Group

AIRWORK SERVICES LIMITED

Bournemouth (Hurn) Airport, Christchurch, Hampshire, BH23 6EB, England
Telephone: Northbourne 2271 Cables: Airwork Xchurch Telex: 41282



The Daring Class destroyer BAP *Palacios* was one of two vessels recently refitted for the Government of Peru at the Birkenhead shiprepair yards of Cammell Laird



ARV *Nueva Esparta* was extensively refitted and modernised for the Government of Venezuela. Two further Venezuelan warships are refitting at Birkenhead and a team of company experts is providing technical advice during the refit of a further vessel in Venezuela

Ship refitting

for warships

Cammell Laird has a proud history of refitting battleships, aircraft-carriers, cruisers, destroyers, frigates and naval auxiliaries for the Royal Navy and foreign navies.

This work is undertaken at the Birkenhead Works by specialists who are constantly kept up to date with improved techniques. The company also provides, under technical aid contracts with foreign governments, on-site teams of highly experienced technicians to guide developing labour forces.

Cammell Laird facilities at Birkenhead include twelve private dry docks, the two largest being 290 × 43 m (950 × 140 ft) and 244 × 37 m (800 × 120 ft); the dry-docks are well supported by ample cranage and a full range of auxiliary services.

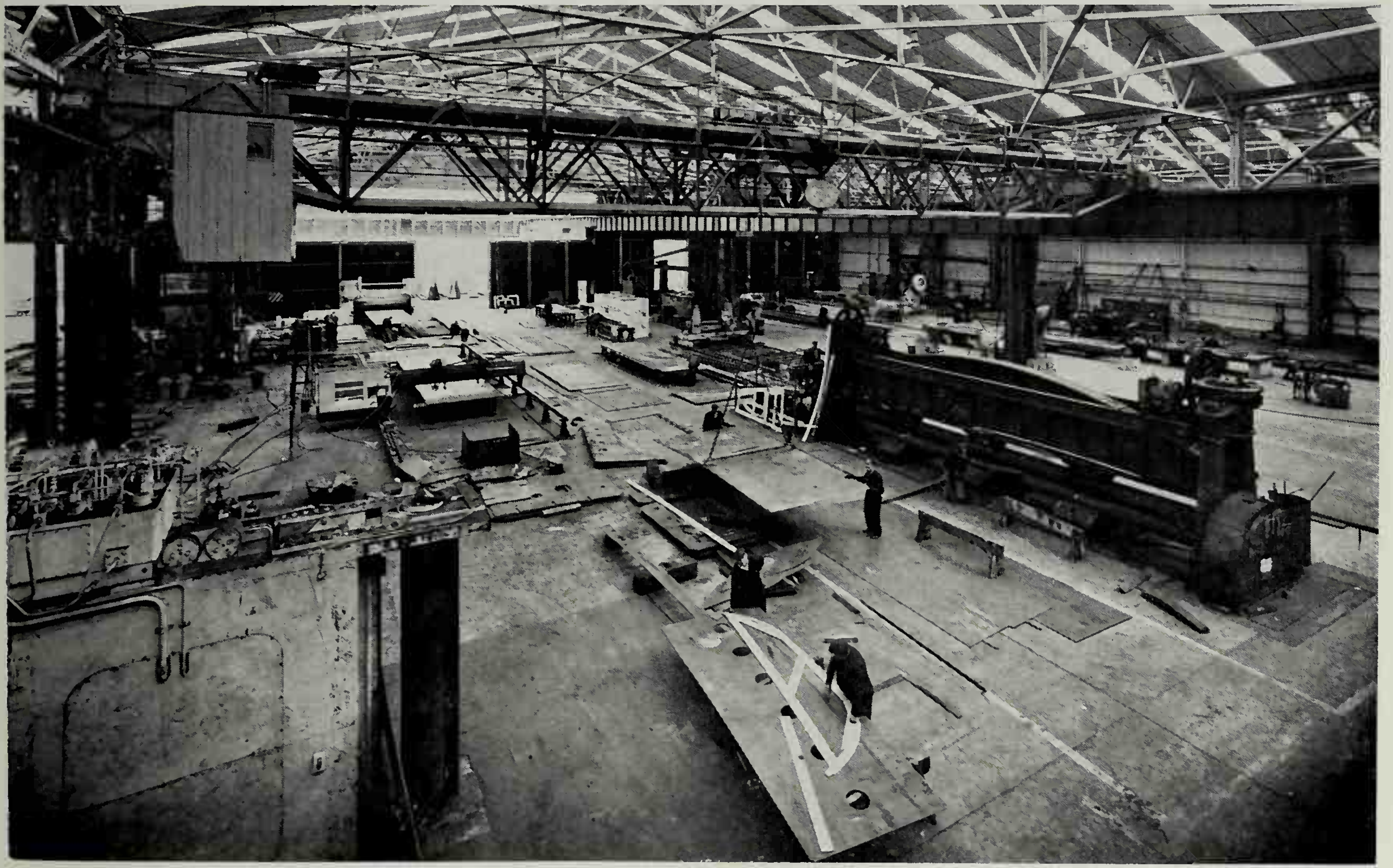
A 56 000 m^2 (14 acre) wet basin, with a 43 m (140 ft) entrance, providing 823 m (2700 ft) of quay space is also served by a wide range of facilities including a 200-ton floating crane.

For the repair and modernisation of electronic equipment and weapon systems, Cammell Laird is supported respectively by the Plessey Company (Marine Systems Division) and A. Robinsons Ltd.

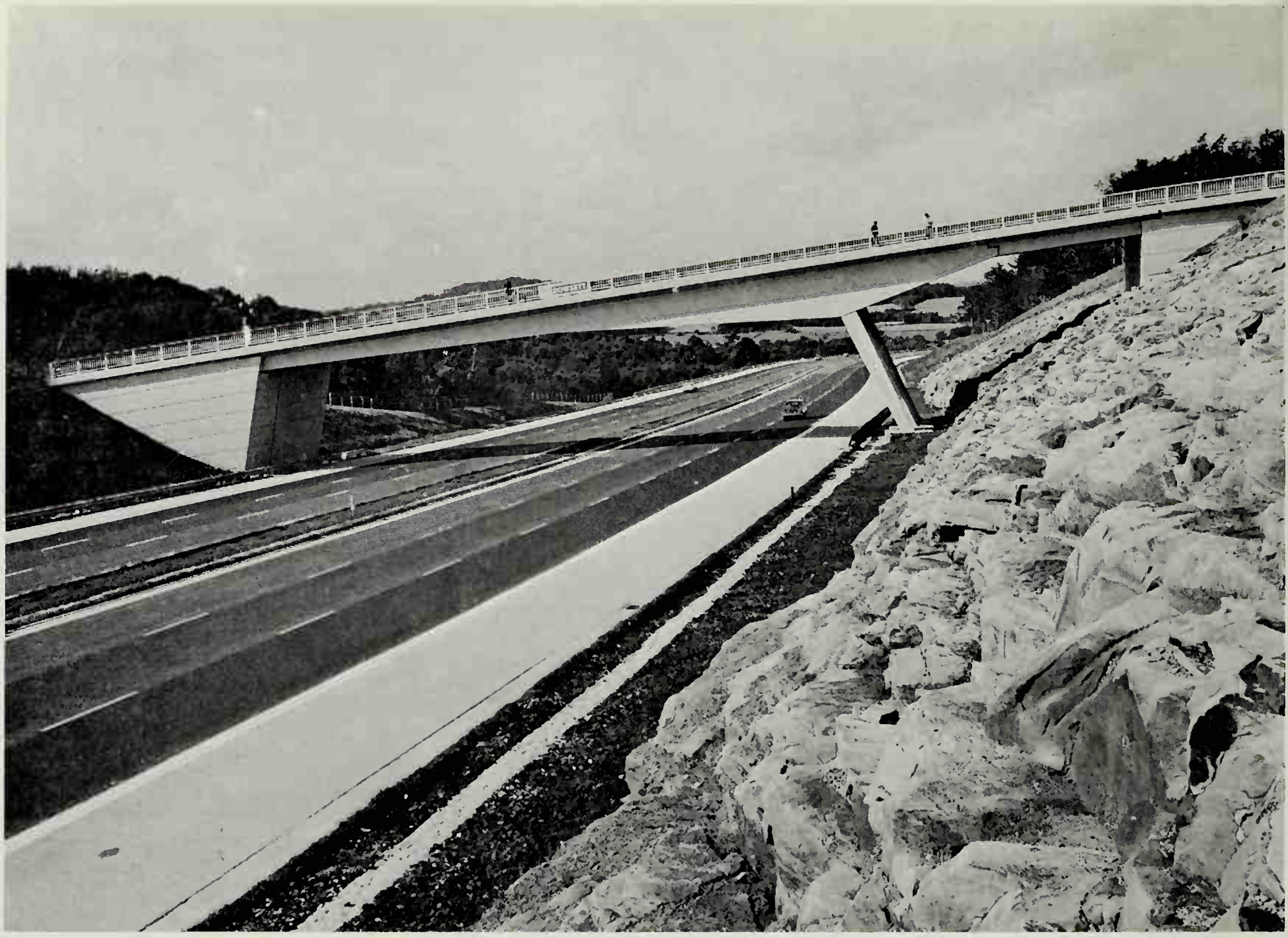
This proven combined service by the three firms, each expert in its own field, is available from the initiation of a project up to the acceptance by the foreign Government of the warship on successful completion of post-refit sea trials.

Above: one of the Cammell Laird machine shops showing some of the engineering facilities available for all types of marine refit work

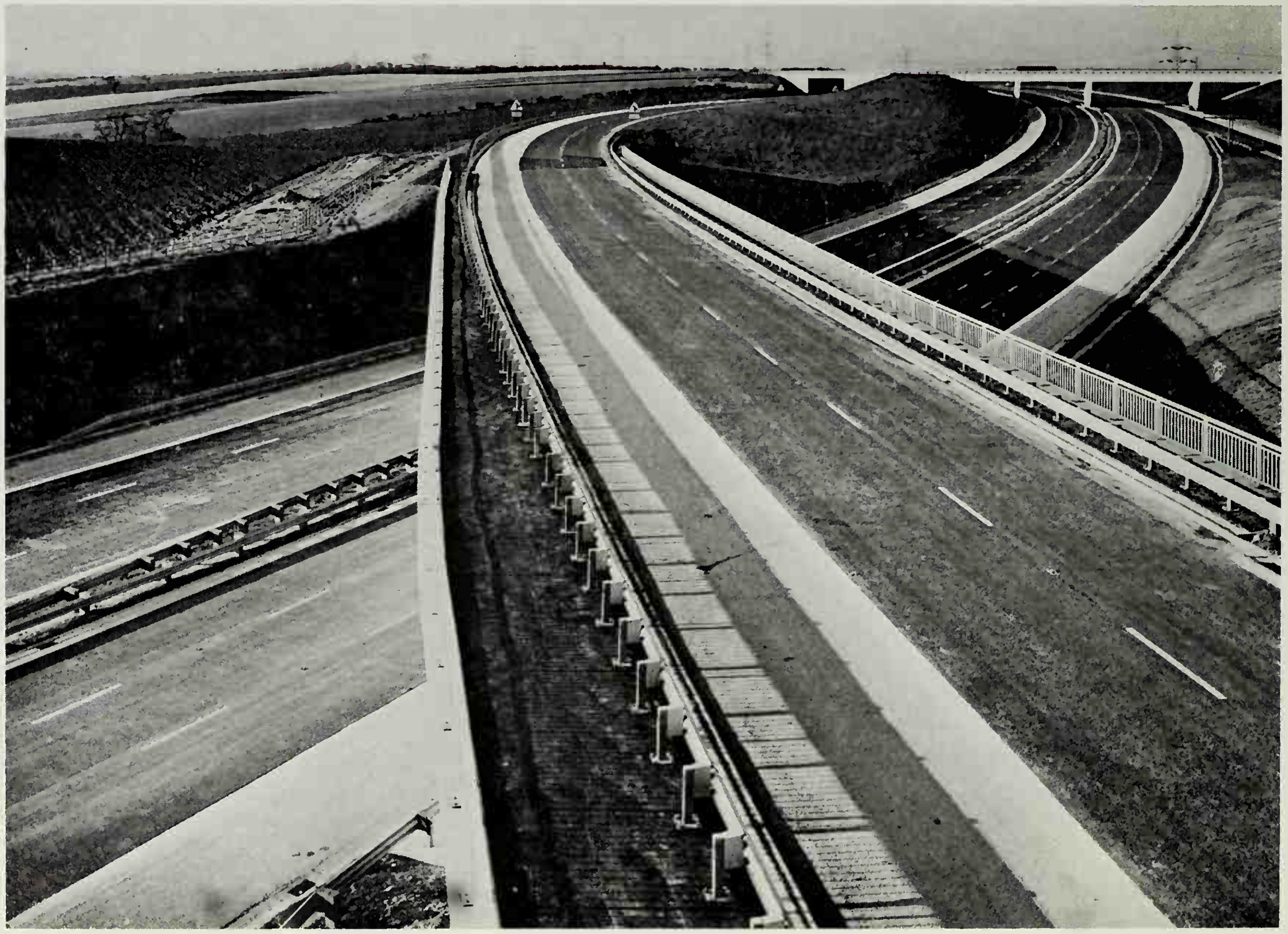
Below: part of the steel working area, where sections up to 50 tons weight can be fabricated and handled



CAMMELL LAIRD (SHIPREPAIRERS) LTD
Birkenhead, L41 5HG, England
Telephone: 051-647 7060 Cables: Drydocks Birkenhead Telex: 627011



Typical examples of motorway planning and construction, including flyovers, underpasses, bridges and slip roads and all associated earthmoving work, carried out by Dowsett Engineering Construction Ltd



Construction services

for defence, industrial and civil projects

The execution of major civil engineering projects has now become so complex that very few firms command expert knowledge in all the fields involved. Dowsett Engineering Construction Limited (a member of the Dowsett Group) has specialised in this type of work, including preliminary surveys, overall design, detail design, specification, costing, construction and final commissioning.

During the past 30 years the company has undertaken all classes of work for Government departments, public and local authorities, as well as private organisations.

During this time it has engaged in a wide range of activities on a national scale, including the construction of trunk roads, bridges, railway modernisation schemes, heavy earthworks, pipelines, office blocks, hotels, multi-storey car parks, industrial factories, piling and heavy foundations.

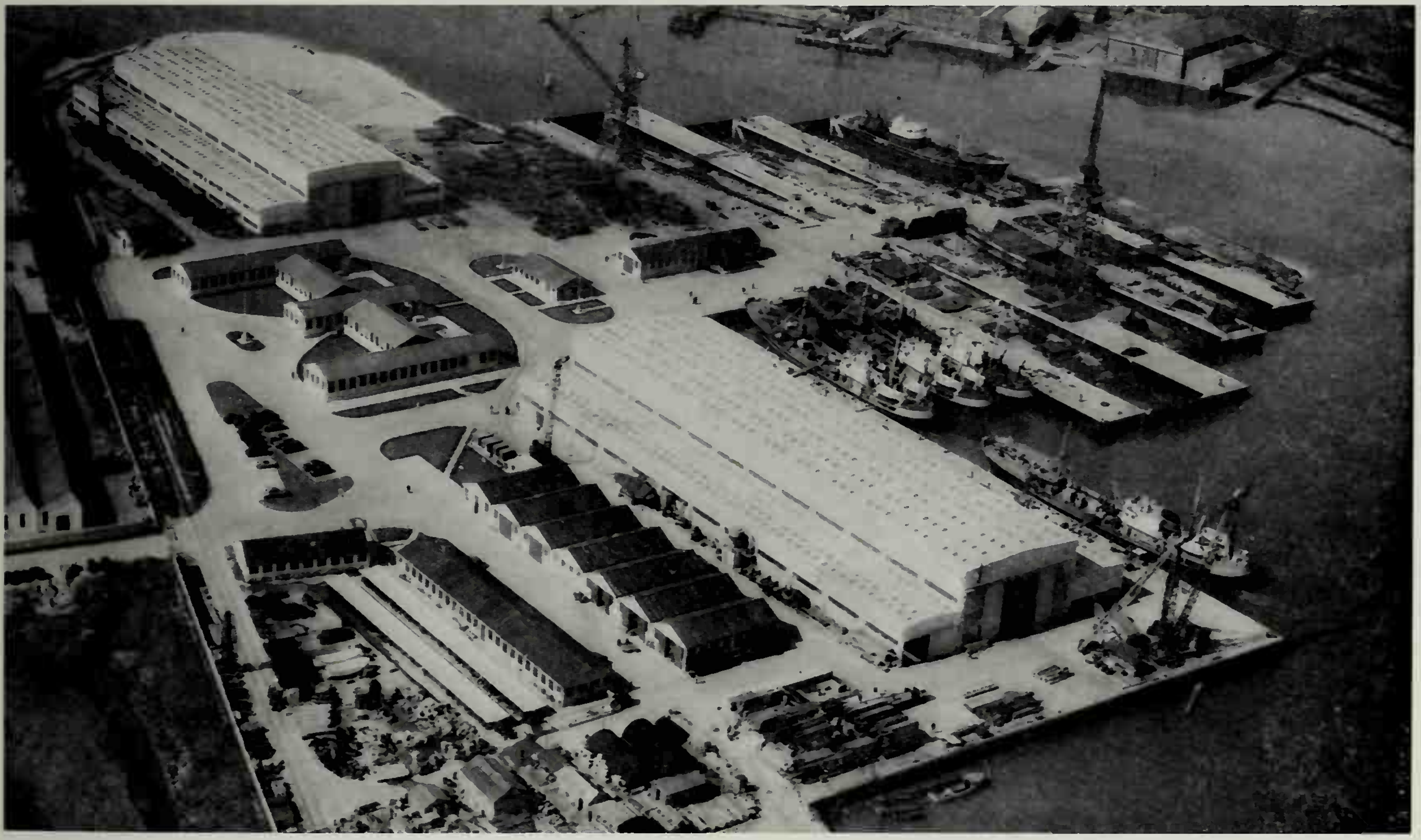
When Britain's first major motorway, the M1, was built between London and Birmingham, the company was responsible for a substantial part of the earth-moving. Since that time it has developed to a high degree the skill and expertise required for road construction and has been responsible for a major portion of the Ministry of Transport's motorway network in the United Kingdom. These contracts have been particularly advanced in the design of the carriageway and bridge structures and in the standard of finish achieved.

With its specialist teams of men and large fleet of modern plant and equipment, the company is now recognised as one of the leading contractors employed by the Ministry of Transport on motorway and road construction throughout the United Kingdom.

In addition to the company's civil engineering work, it also has an active building department; recent contracts include a number of large factories for private industrialists and a luxurious hotel, all of which have been successfully completed to very exacting standards.

The projects which the company can tackle include not only complete naval bases, shipyards, docks, aerodromes and airfields, as well as defence works and fortifications both above and below ground, but also roads and housing complete with all mains services for employees or personnel engaged on the completed project.

Work of this type can be carried out anywhere in the world, with due regard to local conditions and requirements, as well as local labour and materials. Work done includes structures in steel, prestressed and reinforced concrete and aluminium ranging from heavily reinforced defence structures to light-weight hangars.

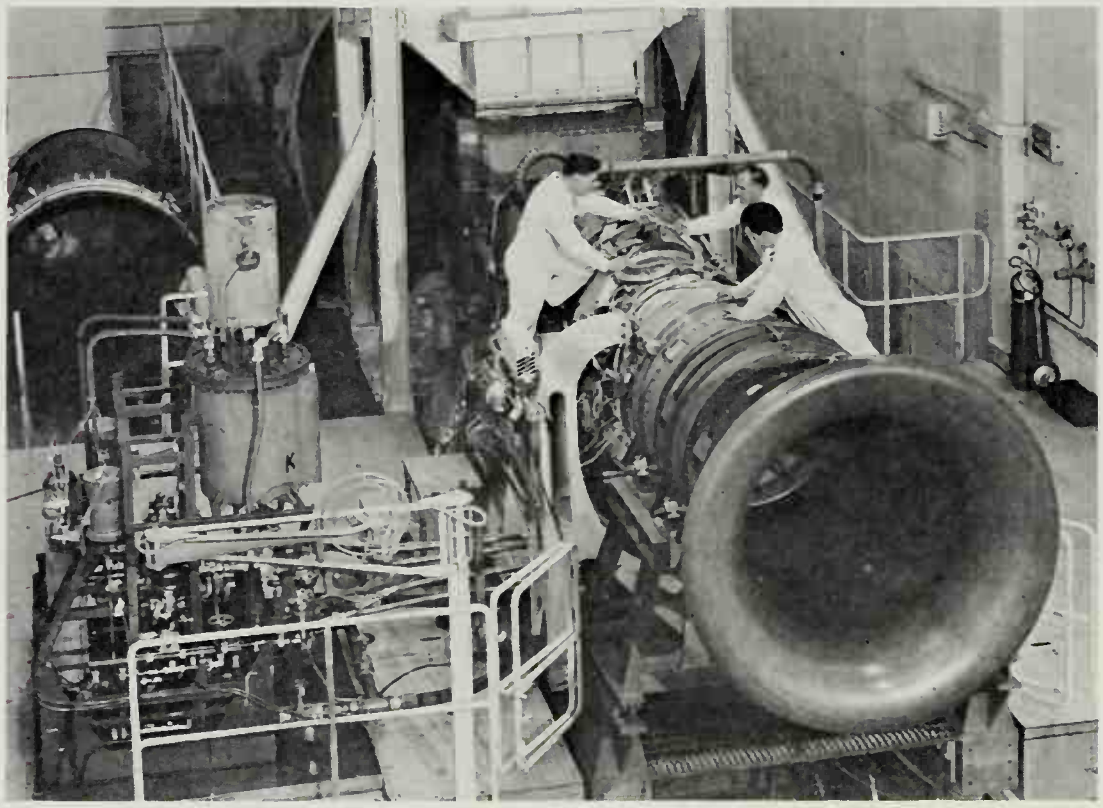


Small shipyard including dry docks, construction and repair shops planned and executed by Dowsett

DOWSETT ENGINEERING CONSTRUCTION LIMITED

Bilton Hall, Harrogate, Yorkshire, England
Telephone: Harrogate 2664 Cables: Dowsett Harrogate

HTS management training centre at East Burnham



Engineers work on an advanced technology jet engine

An HTS training course under way

Support training

of personnel for advanced technology systems

For the past six years HTS Management Consultants Limited has specialised in the field of manpower planning. At all levels, occupational training is an essential part of manpower planning techniques and it is in this field that HTS has built up its world-wide reputation. HTS provides management and supervisory courses, training in English language, scientific and technical subjects, conducts organisational analyses, and advises on all aspects of recruitment and selection procedures. HTS will also establish training schools specifically designed to meet client requirements.

The company's aim is to provide a comprehensive range of services to satisfy all training requirements except those for more specific technical training which would normally be the responsibility of government or industry.

Support training facilities offered by HTS can be divided into five broad activities: training consultancy, training courses, establishments overseas, student administration and residential accommodation.

Training consultancy

Training consultancy activities include the following:

Specification of training objectives
Design of training programmes to meet their objectives
Specification of all equipment (both hardware and software), teaching staff requirements, classroom and facility design, location and administrative requirements
Review of instructional techniques used in existing training programmes
Design and conduct of trainee assessment and course evaluation procedures
Assessment of individual aptitudes for trade and vocational training
Recruitment and selection of associated training and administrative staff of the requisite calibre and experience
Advice on the cost effectiveness of individual training programmes.

Training courses

The subjects in which HTS provides training may be categorised as follows:

Basic and technical English language
Physics and mathematics
Applied sciences such as electronics and engineering
Special technical courses on such subjects as statistics, store-keeping, stock control and accounting
Trade training in such skills as workshop practice and operator training
Management and supervisory training.

Establishments overseas

To provide the necessary facilities for the conduct of the training services outlined above, HTS undertakes to establish training schools overseas on behalf of clients. The following operations would normally form an integral part of a total training package:

Design and building (or modification of) training establishments to meet requirements
Provision of instructional and administrative staff
Specification and supply of all associated furniture and equipment
Specification and supply of text books, instructional equipment such as language laboratories, audio-visual aids and teaching machines, and associated software.

Student administration

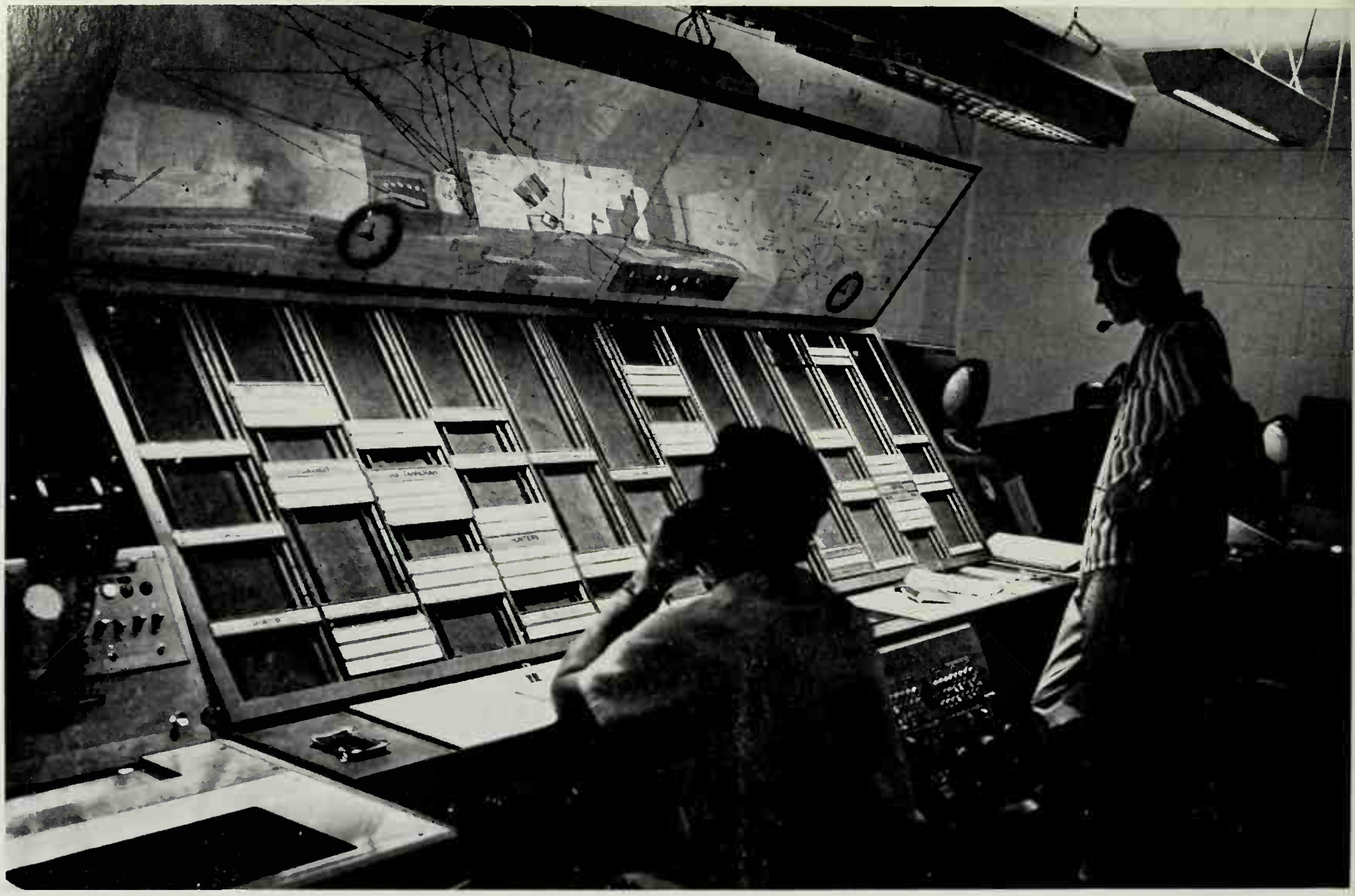
For overseas students whether military or civilian requiring education in Great Britain, HTS undertakes the following activities:

The placement of overseas students in British institutions of further education
The planning and supervision of students' educational careers in the United Kingdom
Arrangement of suitable accommodation
Organisation of vacation courses
Individual instruction
Regular review and analysis of student progress
Counselling of students on educational careers and on personal problems as appropriate
Monitoring of expenditure on accommodation changes and educational fees
Maintenance of all student records, test results, academic progress, movements, etc
Arrangement with British companies for sandwich-course or other training.

Residential accommodation

HTS owns three residential management training centres, all within one hour of Central London. The centres are purpose-built to a high standard. Each centre can accommodate up to 28 persons. The centres may be used either for tailor-made management, supervisory and other advanced courses, or accommodation can be leased (full board included) to clients who wish to conduct courses of their own design.

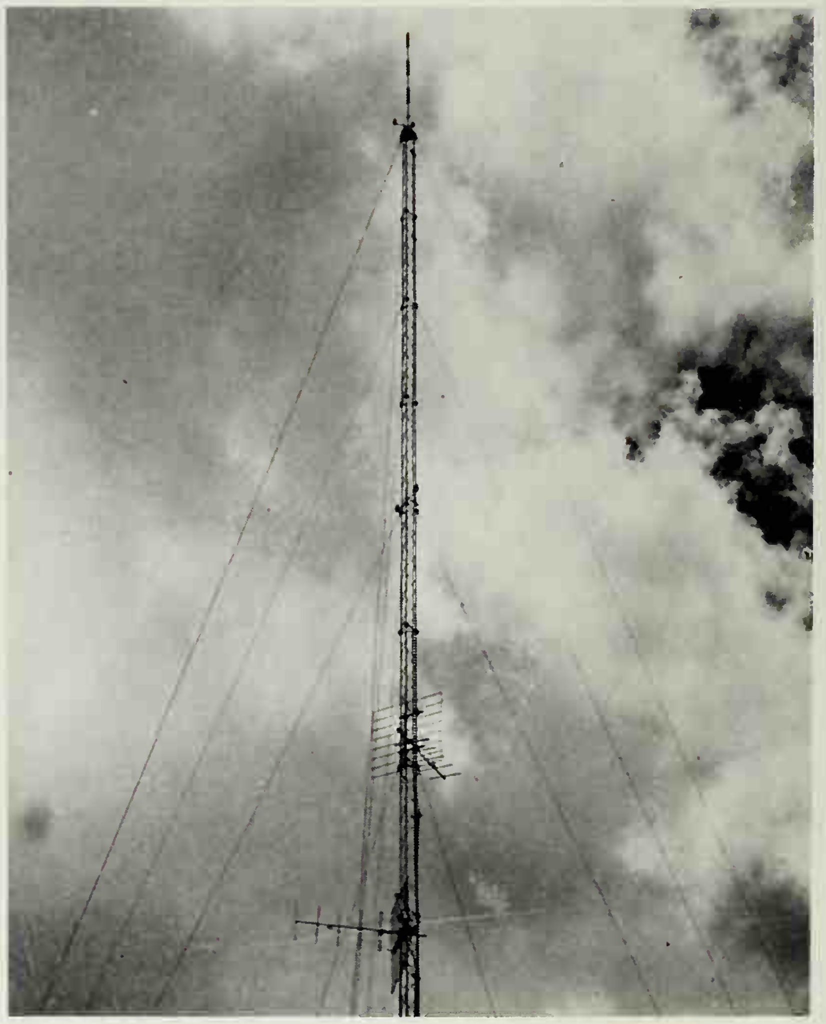
HTS MANAGEMENT CONSULTANTS LTD
29 St James's Street, London SW1, England
Telephone: 01-839 2822 Cables: Airtrain London SW1



International Aeradio Limited has air traffic controllers who are responsible for the safety of aircraft in some 10 000 000 square miles of airspace throughout the world. This includes aerodrome, approach, airway and radar control. In Bahrain a comprehensive service is provided for both military and civil aircraft and this view shows the flight information centre at this airport

IAL operates airport fire services at many places in the world, including Qatar where the complete airport operation is carried out under contract to the ruler HH Shaikh Ahmad bin Ali al-Thani

Sophisticated communications systems are planned, installed and maintained by IAL throughout the world. This aerial system is in the Caribbean, on one of the world's busiest air traffic lanes



Technical services

to military and civil aviation

International Aeradio Limited operates at over 100 stations in more than 50 countries and has established a truly international reputation for the provision of efficient and economical technical services to both military and civil aviation. IAL offers the following services, individually or as a complete package, in connection with the construction, expansion or redevelopment of military aviation bases or civil airports wherever required:

Planning from inception to completion of an airfield complex, whether for military, civil or joint use

Systems engineering for military and civil radar and communications systems, with all necessary links to adjacent agencies

Construction of buildings for any purpose connected with aviation, from an air force operational complex to an airport terminal

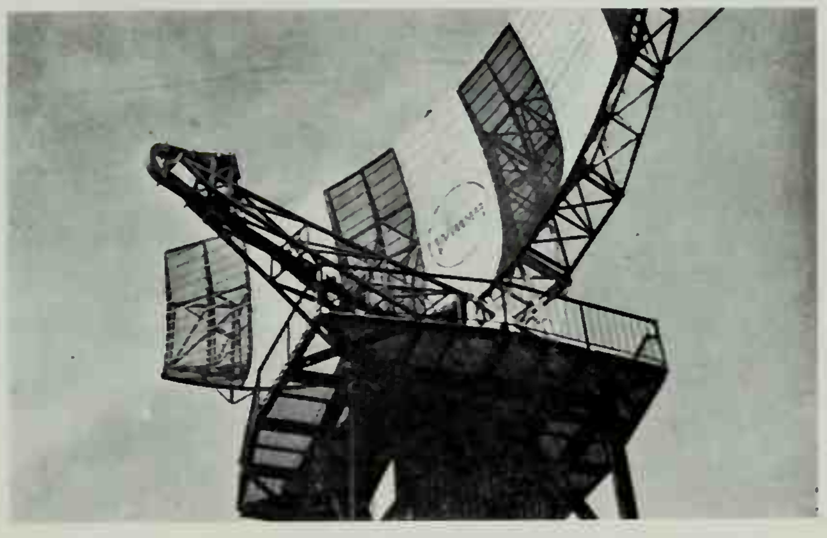
Control organisation, discrete defence force operational centres or civil air traffic control systems

Computers and computer technology for automated message handling, passenger and load control and military applications as required.

Support services

Additionally, IAL can provide at short notice any or all of the following support services, calling as necessary on its worldwide resources and experience:

Installation, operation, and maintenance of all types of aviation technical equipment
Aircraft maintenance
Technical training
Air traffic control
Air defence control and ground-controlled interception
Radio and radar aids to navigation
Ground-to-air and point-to-point communications
Base workshop facilities
Fire, crash and rescue services
Transport



Most of the civil and military radar systems in the Gulf are operated and maintained by IAL personnel

Personnel recruitment
Stores and supply.

Advice on equipment

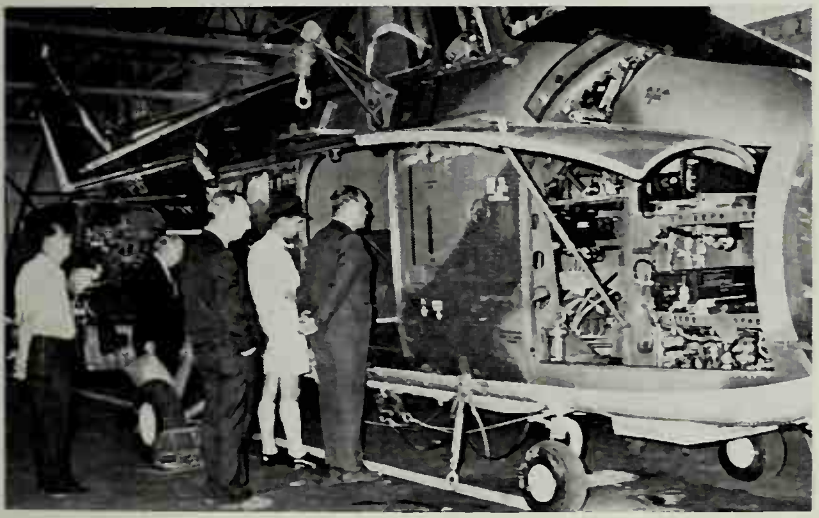
IAL can advise on equipment requirements covering:
Aircraft
Missiles
Communications
Radio and radar aids.

Consultancy

IAL has consortium arrangements with other specialists in design and construction whereby a complete consultancy service can be offered in connection with any military or civil aviation project anywhere in the world.

Work of this type has been carried out in Abu Dhabi, Baghdad, Bahrain, Bathurst, Benghazi, Doha, Dubai, Jeddah, Jordan, Nairobi, Singapore, and Tripoli.

A Whirlwind helicopter undergoing overhaul at an IAL military workshop in the Far East. Inspection, overhaul, repair and training services, as well as spare parts and supply services are available



The IAL Schools in radio and air traffic control are well known throughout the world. Over 600 students of 40 different nationalities have undergone courses at the IAL School, Southall, Middlesex

INTERNATIONAL AERADIO LIMITED
Aeradio House, Hayes Road, Southall, Middlesex, England
Telephone: 01-574 2411 Cables: Intaerio Southall Telex: 24114

IAL

Millbank Technical Services undertakes the design and construction of workshops

MTS undertakes the maintenance of all types of equipment, as well as the training of local personnel for maintenance and other duties

Technical support services

for military and civil authorities

Millbank Technical Services is an associate company of the Crown Agents who, as official agents, have for well over 130 years provided a wide range of services to governments all over the world.

The company offers professional advice on naval and military projects and can enter into contracts to provide a whole range of services including repair, maintenance and training to ensure maximum efficiency and reliability. Training is carried out with the intention of providing the earliest possible hand-over to local personnel.

The company, as part of the Crown Agents' organisation, has close links with the British Ministry of Defence, and is therefore in a good position to provide all or any of the services set out below and in suitable cases can provide credit or extended payment facilities.

Naval and military consultancy services

The company provides naval and military consultancy, including surveys by professional specialists. The evaluation of requirements and the preparation of plans for the development of support projects, particularly in relation to maintenance, repair, training and field support services.

The evaluation of equipments is also carried out.

Naval and military support programmes

MTS undertakes the implementation and management of support programmes and the establishment of essential services, including the provision of operational and technical personnel, the maintenance of vehicles and other equipment and the establishment of field support services.

Design and construction of bases

The planning, design and construction of all types of military bases including harbours, port installations, workshops, radio stations, administration buildings and schools are carried out. The supervision of constructtion and the selection, evaluation and installation of equipment can also be undertaken.

Supplies and stores

The scaling of requirements, the evaluation and purchase of equipment, progressing of orders, inspection and shipment of materials and equipment is undertaken. The establishment of stores organisations and the management of stores and supply services, complete with spares support programmes, can be provided.

Language and technical training

The establishment of defence training overseas, including the provision of instructors and staff, the preparation of syllabuses, the design and installation of training aids, the use of language laboratories, the establishment and management of technical training facilities can all be handled by MTS. The provision of training facilities in the United Kingdom, the selection of technical courses, and the supervision of students from other countries are also among the services offered.

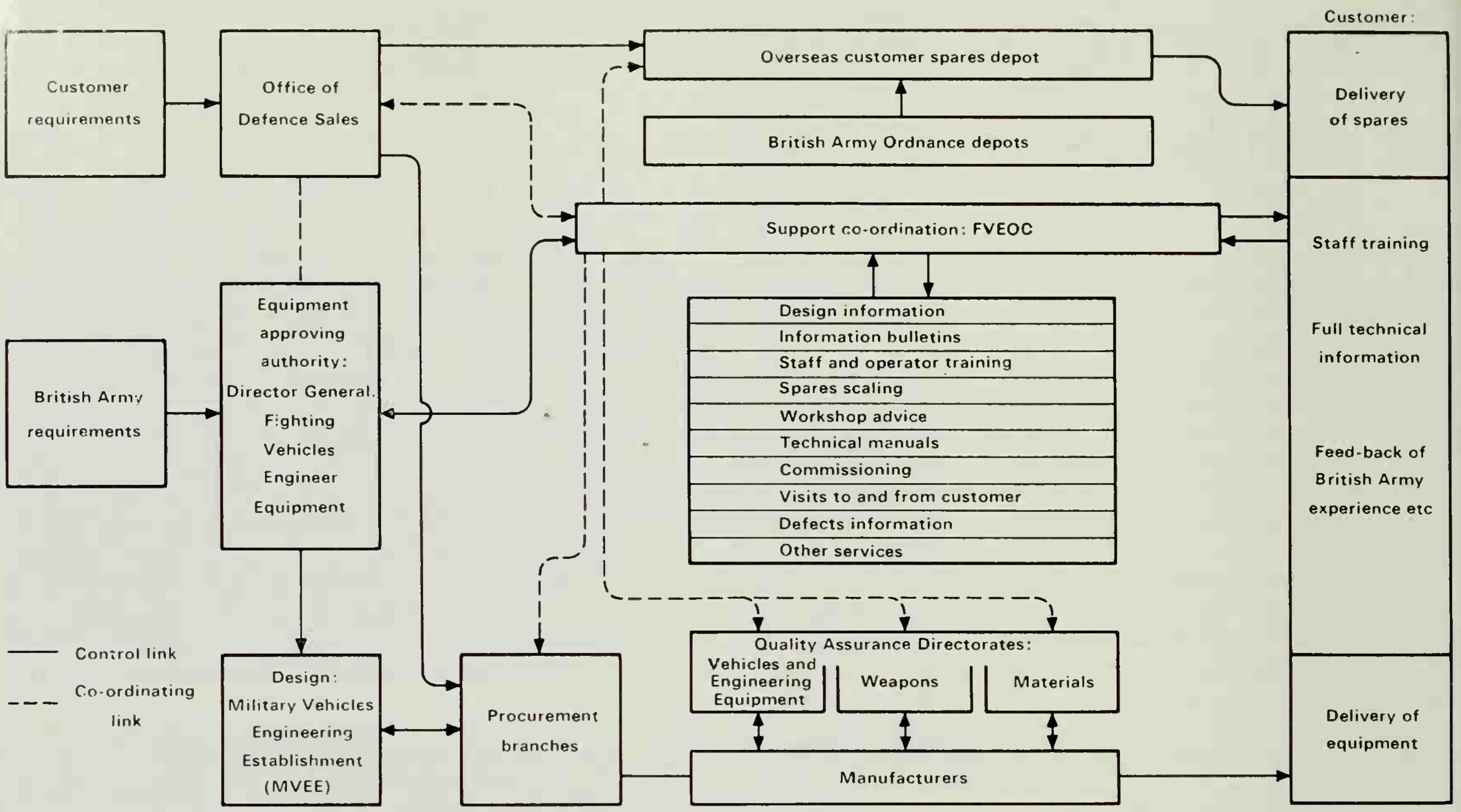
Financial services

In suitable cases, extended terms are available through MTS in respect of construction, equipment and services.

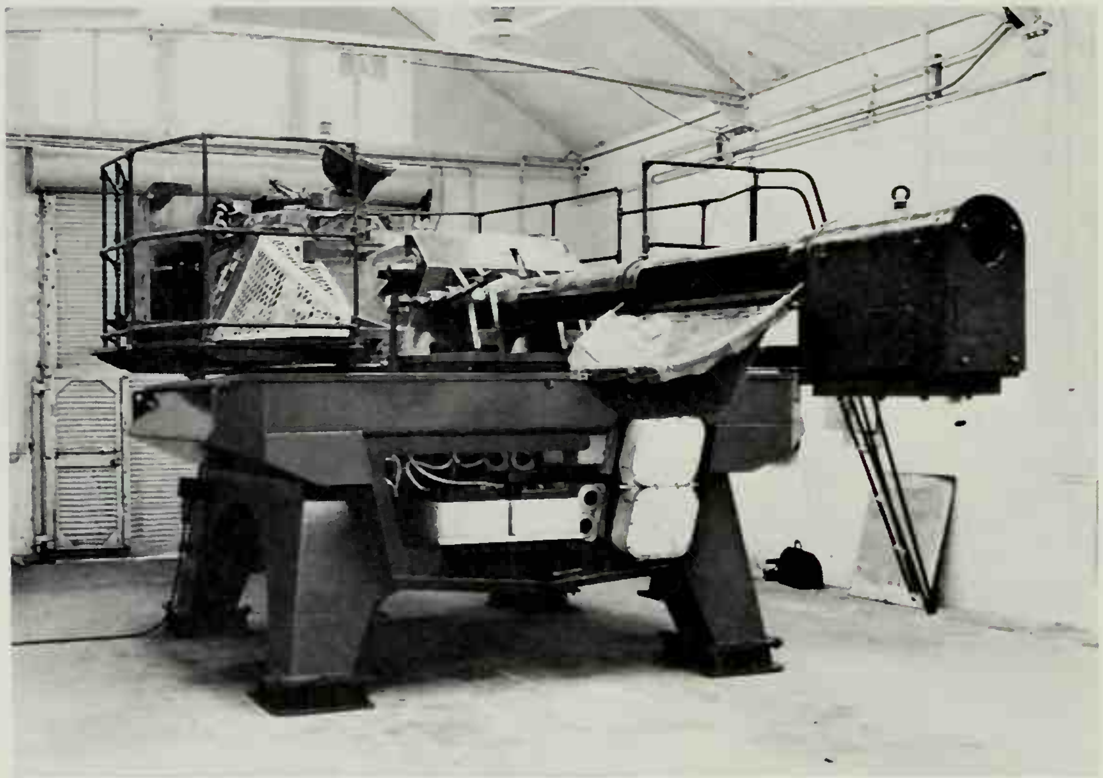
Millbank Technical Services undertakes the design, building and equipping of complete radio stations ready for immediate operation

MILLBANK TECHNICAL SERVICES LIMITED
Luke House, 4 Abbey Orchard Street, London SW1, England
Telephone: 01-222 1145 Cables: Milltech London SW1 Telex: 915623

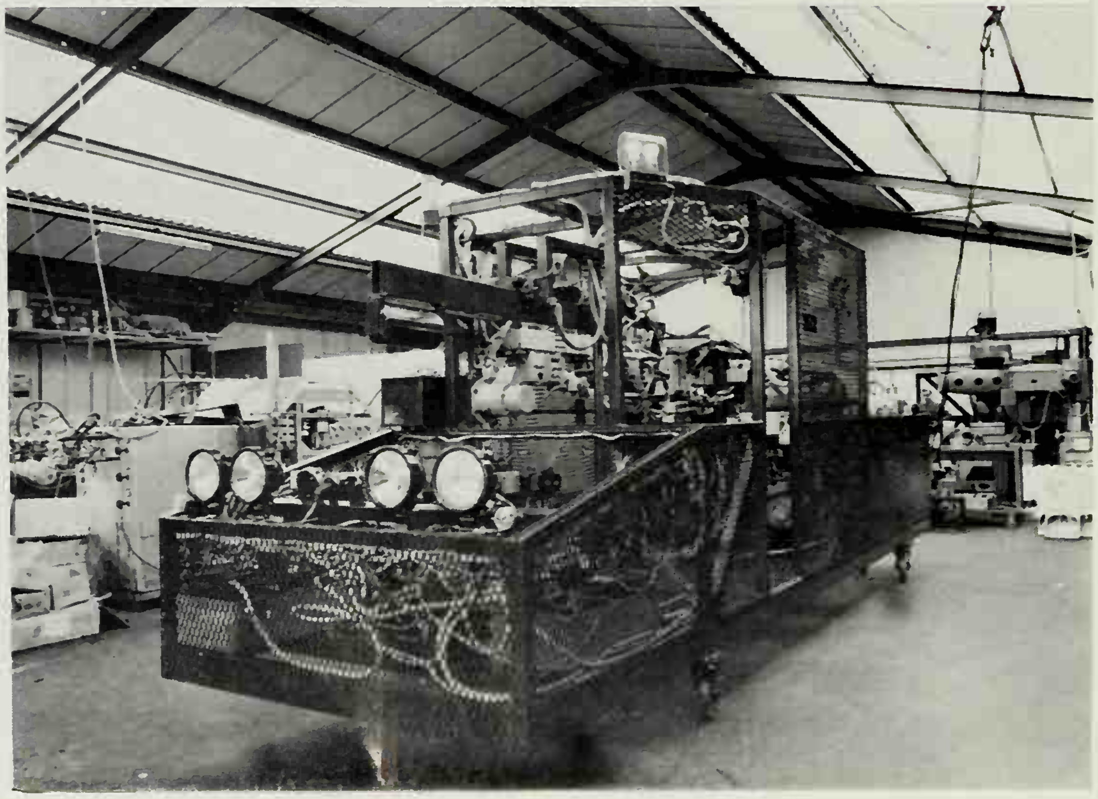
MTS


Customer requirements
Office of Defence Sales
Overseas customer spares depot
British Army Ordnance depots
Customer:
Delivery of spares
Support co-ordination: FVEOC
Staff training
Full technical information
Feed-back of British Army experience etc
Design information
Information bulletins
Staff and operator training
Spares scaling
Workshop advice
Technical manuals
Commissioning
Visits to and from customer
Defects information
Other services
British Army requirements
Equipment approving authority: Director General, Fighting Vehicles Engineer Equipment
Control link
Co-ordinating link
Design: Military Vehicles Engineering Establishment (MVEE)
Procurement branches
Quality Assurance Directorates:
Vehicles and Engineering Equipment
Weapons
Materials
Manufacturers
Delivery of equipment

Above: Flow diagram showing the full extent of the involvement of all British Army technical and operational branches in the after-sales service rendered to users in government-to-government purchases of armoured fighting vehicles



This typical training aid is for gunnery instruction. Tank gunners are trained in a completely realistic situation in perfect safety and without need to visit a gunnery range



This spatially correct skeleton layout of the electrical equipment and circuits of a Chieftain tank is another example of the special aids available to train crews and technicians

After-sales service

for British military vehicles and engineer equipment

The purchase of military equipment is only the first step towards an effective fighting force—unless the equipment is efficiently operated and maintained, it cannot be effective. The British Government, through the Ministry of Defence, therefore offers a comprehensive after-sale service in respect of military vehicles and engineer equipment purchased on a government-to-government basis.

Continuing expert advice and support is available before, during and after delivery. The following summary highlights only the main services rendered:

1) Following discussions in the UK or in the user's country, recommendations are made on adapting existing equipment to local conditions and specialised needs.
2) Technical literature is provided for the operation, maintenance and repair of equipment.
3) Special tools and equipment for base or field workshops can be supplied.
4) The type and quantity of spare parts and assemblies required for a given number of vehicles or equipments under given conditions of usage can be established, based on practical experience in British service. Similarly, advice on maintenance schedules, services and facilities (including workshop equipment) can be given.
5) Training of crews, operators and maintenance technicians can be undertaken at British training centres in the UK or abroad, or advice on the establishment of training centres can be given.
6) An information service is available to provide users with details of any modification of equipment being carried out by the British armed forces to improve performance, reliability or safety in service.
7) If required, faults occurring in service can be investigated on the spot by British military experts and recommendations for repair and prevention can be made.
8) An efficient spare parts supply for armoured fighting vehicles is maintained to ensure the uninterrupted availability of all equipment at all times.

The flow diagram on the opposite page shows clearly the complete involvement of Ministry of Defence research, production and spares provisioning organisations backed by British Army expertise in providing a continuous after-sales service to users of British equipment purchased on a government-to-government basis. (In some cases the service can also be provided where equipment is purchased direct from manufacturers.)

Training service

One of the biggest advantages of sharing in the experience of the British Army through government-to-government purchasing is that users have full access to the training methods and equipment worked out for the British armed forces. This includes syllabuses, audio-visual aids and training aids such as mock-ups, sectioned assemblies, ghosted hulls and skeleton layouts of electrical, hydraulic and other circuits.

SHIPPING DESPATCH
MOSOC
(Repayments)

A small part of the MoD stores, holding more than 26 000 different items of armoured fighting vehicle spares maintained at levels ample to meet any foreseeable demands from users

Trained instructors and specialist technicians of all grades can give advice on training courses. By arrangement, user's key personnel can also be trained at British establishments alongside British Army trainees.

Spare parts service

The full experience of the British Army of operating equipment in all parts of the world, and the spare parts and service organisation required to maintain it in a state of instant readiness, is available to users.

In addition, spare parts can be purchased through Ministry of Defence channels, whose Sales Spares Depot provisions adequate stocks at all times to meet foreseeable demands from all users. Parts required to carry out modifications introduced from time to time are available at the same time as they are supplied to British Army units.

Information service

Frequent bulletins inform users not only of modifications to equipment carried out, but also provide information on performance under various conditions, advice on maintenance and repair, details of malpractices to be guarded against, warning of operational hazards in different environments and other vital data.

This type of information is derived from practical experience under active service conditions in all parts of the world, in all types of climate.

In addition, expert advice is available at all times to meet specific technical or operational requirements and problems.

Full details of these and other supplementary services are contained in a brochure called 'Guide to after-sales service for British military vehicles and engineer equipment'. This brochure, as well as any further information, is available from the British Ministry of Defence, at the address given below.

MINISTRY OF DEFENCE
Director of Sales (Army)
St Christopher House, Southwark Street, London SE1, England
Telephone: 01-928 7999

BASIC EDUCATIONAL TEACHING AID
PLANETRON
BETA
प्राथमिक शिक्षा एवं शिक्षण सहायक
PLANETRON
LIBYAN DEFENCE FORCE
FERRET SCOUT CAR
HANDBOOK-POWERPACK
PLANETRON
MACHINERY PLANT OPERATING MANUAL
ESSO COPENHAGEN
VIGILANT
OPERATOR'S TEST INSTRUCTIONS
SIGHT CONTROL TESTING
PLANETRON
design
from basic theory step-by-step to application
PLANNED PROGRESS
by
PLANETRON
a step-by-step method of technical training
F.I.M.S. HANDBOOK
PLANETRON

Above are some typical examples of operating, maintenance and training manuals produced by Planetron. These manuals are in use with armed forces in many parts of the world.

The Planetron system of information presentation is based on the maximum use of clearly presented illustrations, with the minimum of explanatory text.

The text may be in English, in any language required, or in both.

Every manual is closely tailored to suit the specific purpose for which it is required and is prepared by Planetron staff who are experts in the subject covered as well as in the presentation of technical information in general

Support documentation

Operating, maintenance and training manuals

The increasing complexity of modern equipment demands that when such equipment is supplied to the user, it should be accompanied by all the information required for its operation and maintenance.

Such information should be presented in a clear and concise manner, in the language and in the form best suited to the man who is required to absorb the information.

This is of particular importance in the case of military equipment for which a large number of operators must be trained.

The problem

Manufacturers are rarely able to offer effective training manuals, because while they undoubtedly know all about their own equipment, they cannot be expected to be expert in modern training methods.

Moreover, manufacturers rarely have competent translators for the many different languages in which an operating or training manual may be required. Translating is a highly skilled job best left to the experts.

The solution

Planetron has formed a division to fill this information gap between manufacturer and user. Staffed by engineers, writers and experts in the presentation of information, and with a wide circle of translators, the company specialises in the production of technical publications for industry and the armed forces, on an international scale.

The method adopted by Planetron is to break away from the conventional primary reliance on English text, by employing a technique whereby all essential information is interpreted and conveyed by the skilful use of illustrations. The small amount of supporting text that still has to be used is of the simplest possible nature, and the translated version, which is quite easily and cheaply obtained, is incorporated with the rest of the materials during production.

Information gathering

The information required for any specified purpose is obtained from detailed engineering studies of the equipment supported by information collected from the manufacturer's own technical records. Prior to processing, all selected information is validated by confirmation with the manufacturer. The whole of the material to be utilised will, by the use of the Planetron techniques, adequately fulfil the primary task, that is the presentation of easily assimilated information to the complete satisfaction of the user.

Information processing

All relevant information is arranged in logical, identifiable sequences according to function or practical use.

The sequences are developed in a form whereby the information is primarily conveyed by illustration, with a minimum of supporting text.

Presentation

The information is presented with illustration and text on the same page. Pages are bound at the top, so that the simplified English text, reading from left to right, can be more easily matched by the translated version in a language using a different convention.

Application

The material is designed to be equally suitable for formal classroom instruction, or for workshop or 'on the job' training.

The format and information content of each manual are such that after use in training it can continue to be used by personnel as reference material for the operation and maintenance of their equipment and systems.

If a technical support service by British personnel is initially provided, the use of Planetron material will greatly assist progress towards the ultimate taking over of responsibility for the project by the local authority's personnel.

These techniques are completely universal in their application with regard to subject matter and languages. Special attention has been devoted to the needs of military personnel. In this specific area they are at present being extensively and successfully used.

Cost estimates

Planetron can formulate proposals with cost estimates for the provision of material on the above lines in support of equipment or systems in any field of engineering. Estimates can be on a fixed or budget price basis, as required.

PLANETRON (OPERATIONS) LIMITED
419 Richmond Road, St Margarets, Twickenham, Middlesex, England
Telephone: 01-892 8854

PLANETRON

Procurement, acceptance tests, spare parts provisioning, maintenance and crew training are available for all types of vehicles

Technical and tactical training can be provided for operational crews and base personnel, using the latest training aids

A typical spare parts store and maintenance workshop designed and completed by Technical Support and Services Limited

Technical support

for defence forces

Defence departments throughout the world will be only too well aware that as defence equipment develops in efficiency, it also becomes more complex, and that this fact could place a considerable strain on the technical and other resources of defence forces, particularly those which are relatively small and have to develop rapidly a capability in the latest defence techniques.

Without specialist assistance a defence force might find it impossible to master comparatively new equipment such as high-performance armoured vehicles, radio-radar and electrical equipment. At the very least, re-equipment in these fields calls for an intensive training programme.

This is necessarily a restricted and highly specialised activity and because of the discreet nature of this class of operation, it may not be commonly known that assistance is available through the medium of our organisation which has, over a period of many years, specialised in this type of work.

Backed by our main organisation in Jersey, Channel Islands, we are in a unique position to offer a complete and comprehensive technical support service for British armoured vehicles and other military installations including radar and communications systems.

Design and layout of base workshops

Technical Support and Services Limited maintains its own design organisation with the capability of designing base overhaul workshops built to suit a defence department's vehicle overhaul requirements. Designs can include dimensionally positioning overhaul plant, equipment, tools, services, etc., applicable to the vehicles and to the level of repair required.

Advice and supply on workshop and special equipment

We provide a special advisory service by which, at the invitation of an overseas government, we send a specialist team to evaluate and discuss a technical support project and submit complete and detailed proposals for consideration by the government concerned. Our organisation is offered as a complete military function, with full regard to service procedure.

Following equipment selection by the defence department, we can, if necessary, act as technical agents and advise on modifications which might be required to standard equipment, providing acceptance and delivery facilities on behalf of the government. The range of equipment covered meets all the various needs of defence forces, including vehicles, communications, and armament, all with necessary support ground equipment, test equipment and spare parts.

Introduction of overhaul systems and associated documentation

We also provide advice for the introduction of overhaul systems and associated documentation for routing the vehicles or equipment being overhauled through their various stages on dismantling, inspection, reclamation, rebuild and testing. By this means the entire history, including modification standard of the overhauled equipment, is placed on record for future utilisation.

Spares provisioning

After some years' experience in this field, we have perfected continuous spares provisioning techniques. Our supply centre can advise on stock holdings, user scalings and the appropriate demand systems. This service can include the co-ordination of all the demands of the many manufacturers and suppliers normally involved, undertaking actual purchases, and supervising packing and delivery by the most suitable system for economy, having regard to the urgency of individual requirements.

Training personnel

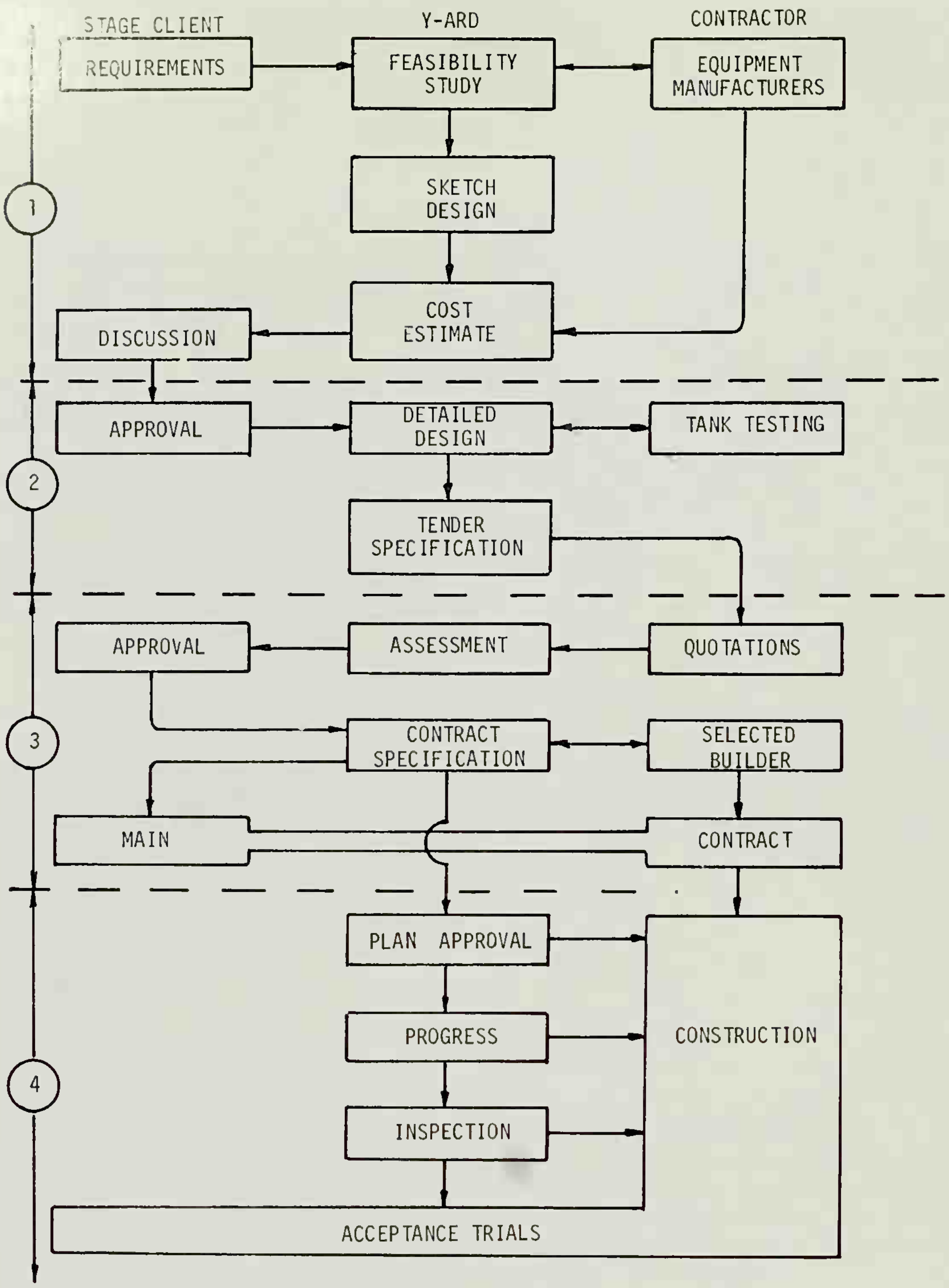
Comprehensive training programmes for technical staff in the operation and maintenance of equipment can be provided at our technical training centre in Jersey.

Crew training on vehicles

We can also undertake the complete operation and tactical training of drivers and crew members in their own country.

TECHNICAL SUPPORT & SERVICES LTD
Route De La Haule, St Brelade, Jersey, Channel Islands
Telephone: Jersey Central 25301 Cables: Avio Jersey Telex: 41161

TSS


STAGE
CLIENT
Y-ARD
CONTRACTOR
REQUIREMENTS
FEASIBILITY STUDY
EQUIPMENT MANUFACTURERS
1
SKETCH DESIGN
DISCUSSION
COST ESTIMATE
APPROVAL
DETAILED DESIGN
TANK TESTING
2
TENDER SPECIFICATION
APPROVAL
ASSESSMENT
QUOTATIONS
3
CONTRACT SPECIFICATION
SELECTED BUILDER
MAIN
CONTRACT
PLAN APPROVAL
PROGRESS
CONSTRUCTION
4
INSPECTION
ACCEPTANCE TRIALS

This diagram shows the various main stages and operations in the conception, design, construction and acceptance of a ship and the role played in all this work by Y-ARD. Stage 1 covers the basic design, stage 2 the detailed design work, stage 3 is the detailed costing to the point of awarding contracts, and stage 4 includes actual construction and final acceptance trials. Y-ARD offers its services for any stage of this work or for the entire project.

This project flow chart is typical, but it can be amended as required to meet special circumstances.

As can be seen below, operational advice and assistance are also available after commissioning of a ship, for as long as may be required.

Strategic and economic studies

Strategic studies start with an analysis of possible maritime threats and of the national resources available to meet them. The complete analysis leads to detailed costed programmes for the acquisition of equipment, and the recruitment and training of personnel.

Similar projects in the non-military field include surveys and predictions of markets for ships and equipment, the optimisation of ship types for particular trades, and recommendations for improving cargo handling at ports.

Operational advice and assistance

Project planning and management

This includes the overall control of a number of complex development projects, including the work of many sub-contractors. Computer-based techniques, such as network analysis, are used where appropriate. Y-ARD is prepared to act either as prime contractor with overall responsibility for the project, or as consultant acting on the purchaser's behalf.

Maintenance and base facilities

Studies are carried out on the bases equipment and organisations required to meet forecast operational and maintenance needs.

Training

Detailed studies are made of training requirements, including syllabi, timetables, and lists of training equipment required.

Refit planning and configuration control

The maintenance of complex modern warships absorbs an increasing proportion of their life. The problem of reducing the cost and time for maintenance while increasing its effectiveness is tackled by:

Precise identification of all equipment fitted
Planning the maintenance in detail
Minor modifications to ship design where these can have a large effect on maintenance time
Increased productivity by using specialised teams and equipment in dockyards.

Technical and operating handbooks

Personnel having practical operational experience are employed in writing operating handbooks for the Royal Navy and commercial organisations. The work includes systems descriptions, normal and emergency operating instructions. These handbooks are used at sea, for industrial plant operations and in training establishments.

Naval consultancy

Design, strategic and marine services

Y-ARD Limited is a marine consultancy, created in 1946. It has since carried out numerous projects and investigations in many different fields not only for the Royal Navy, but also for Commonwealth, NATO and other navies, the shipping and fishing industry and general industry, including the overall administration of large development projects involving the work of many different sub-contractors.

The internal organisation of Y-ARD is flexible and, by developing only those resources appropriate to the task, can control both large and complex projects and simple contracts at minimum cost to the client. The most up-to-date management techniques are used. The possession of a large experienced design staff, backed by modern equipment (including an ICL 1903 digital computer and an AEL 680 analogue/hybrid computer), ensures that the consultancy service provided is sensible and practical.

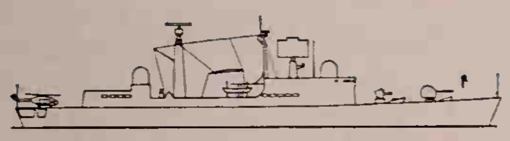
Ship designs

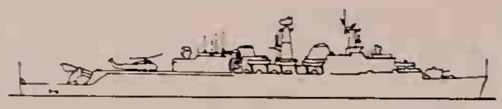
Ship design studies include designs for all types of naval vessels as well as for fleet auxiliaries, merchant ships, survey and research ships and fishing vessels of all types.

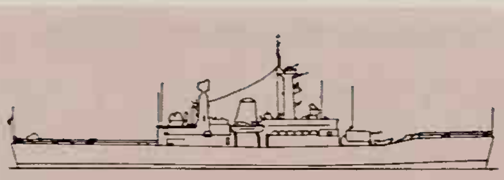
The services offered include optimisation of ship type, detailed design and specification, analysis of tenders, approval of builders' drawings, inspection during building, and conduct of trials.

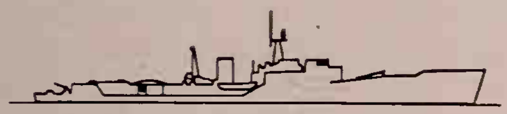
Machinery design

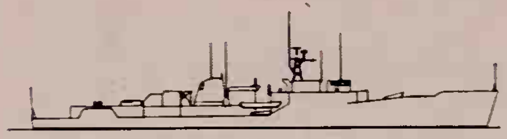
Y-ARD has carried out machinery studies on all types of vessels ranging from submarines to aircraft carriers and for all types of machinery, including steam turbine, diesel, gas turbine, turbo-electric, nuclear and combined plants. The organisation has been particularly involved with ships of the frigate and destroyer type and the machinery installation design of most of the post-war Royal Naval ships of those types has been carried out by Y-ARD under the direction of the Ministry of Defence (Navy). These include the Whitby Class frigate (steam turbine), Blackwood Class frigate (steam turbine), County Class destroyer (COSAG), General Purpose frigate (COSAG), Type 82 destroyer (COSAG), Improved Leander Class frigate (steam turbine), and Type 42 destroyer (COGOG), for which complete specifications and guidance drawings were prepared. The technical documentation, including guidance drawings, were prepared for the conversion of HMS *Exmouth* to all-gas turbine propulsion.

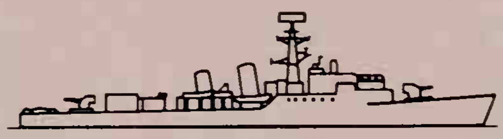

TYPE 42 DESTROYER

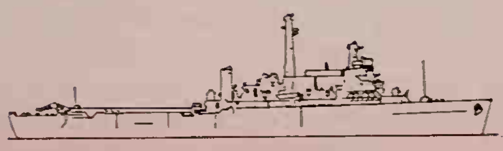

DEVONSHIRE CLASS DESTROYER


LEANDER CLASS FRIGATE


BLACKWOOD CLASS FRIGATE


EXMOUTH CONVERSION FRIGATE


TRIBAL CLASS FRIGATE


FEARLESS CLASS ASSAULT SHIP

FAST FLEET REPLENISHMENT SHIP

Y-ARD has also carried out machinery studies or the preparation of machinery specifications and guidance drawings or other major work on:

- Landing craft
- Minesweepers
- Logistic support ship
- Assault ship
- Fleet replenishment ship
- Depot ship
- Nuclear tanker
- Nuclear icebreaker
- Nuclear warships
- Frigates and destroyers
- Escort cruiser
- Aircraft carrier

In addition, work has been carried out on such detail projects as steam catapults and accumulators, total energy installations, gas turbine modules, pressure combustion boilers, machinery surveys, shore boiler test facility, machinery test house, transmission system shore facility, machinery shore trials, shock and noise machinery mountings, machinery controls, ship and machinery dynamics, machinery handbooks, tender assessments, and ship maintenance and refit.

In recent years there has been a major expansion in the size and scope of the organisation. Consultancy on an international scale is now offered on complete naval ship designs covering naval architecture, marine engineering, electrical and communication engineering and weapons engineering. The consultancy includes all or part of preliminary feasibility studies, deep feasibility studies, specifications and guidance drawings, and continuation services.

Y-ARD LIMITED
PO Box 4000, 1395 South Street, Glasgow W4, Scotland
Telephone: 041-959 1251 Cables: Yard Glasgow Telex: 77380

Y·ARD

Industrial power plants

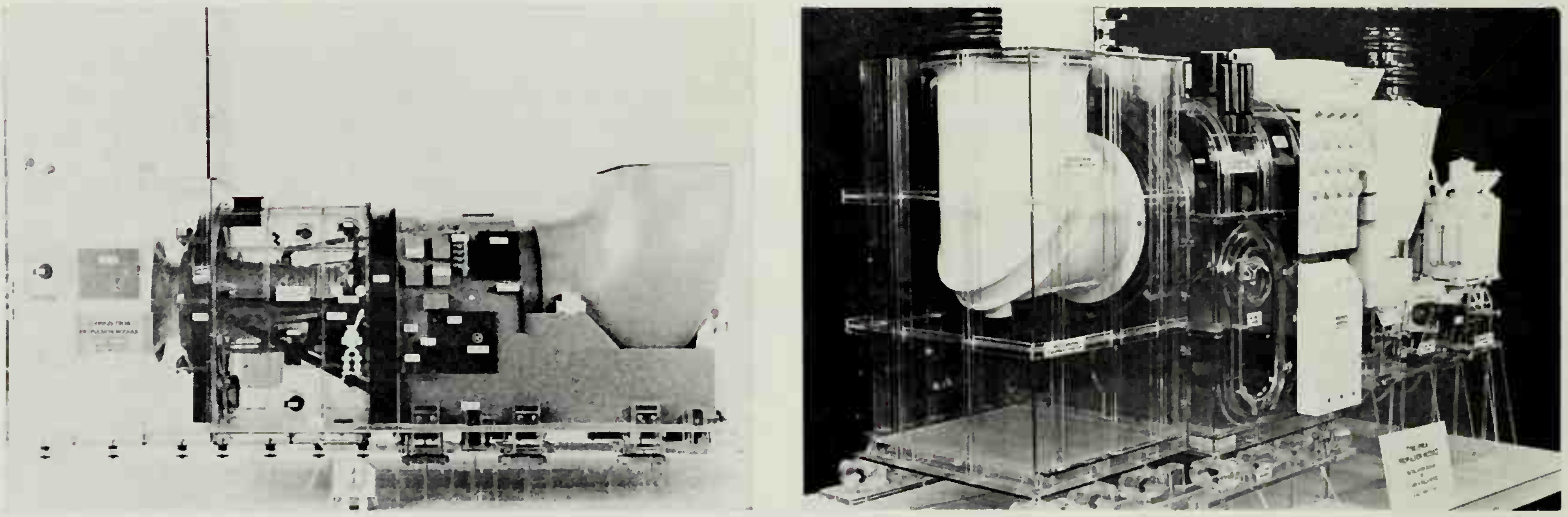
A service is offered which can assess clients' requirements for energy consumption of all forms, and design and produce integrated power plants to provide this energy as and when required with maximum economy.

Y-ARD's 20 years' experience of the design of power plants for ships is directly relevant to the problem of integrating the varied energy requirements of a factory, a hospital, or any other industrial undertaking.

Y-ARD can act as consultants either for recommending the most efficient way of using existing plant, for extending the existing plant to meet future demands or for designing and installing a new plant.

Model making

Models, mockups and simulation, either on a full or reduced scale, are some of the most powerful tools available to assist people to comprehend complex problems, and are widely used in Y-ARD studies. They are often particularly valuable for the communication of technical ideas to non-technical people, who may be unfamiliar with the details of a problem. Y-ARD has its own model makers, and full-scale mockups can also be built if required in the large machinery test shop. Models can be made either in rough form as working tools or to full demonstration standard.



Scale models of gas turbine modules

Merchant shipping group

The following is an indication of some of the projects which have been carried out by the Y-ARD Merchant Shipping Group.

(1) A comprehensive study into nuclear-powered ore carriers and nuclear-powered container ships

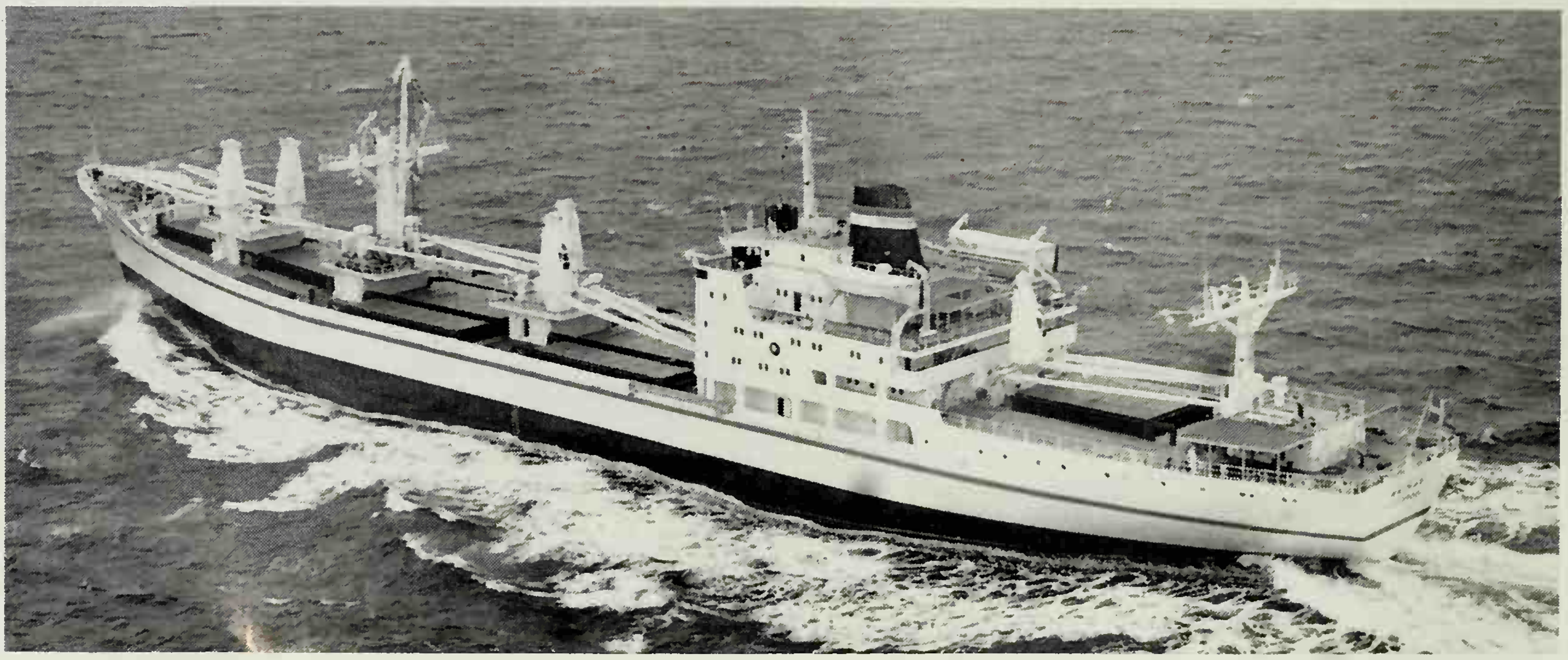
(2) The design of a nuclear-powered icebreaker, safety arrangements and the shore support required for the building, fitting out and operating of this ship

(3) Cargo-carrying container ship, pyrites carrier, bulk cargo carrier, container ships, advanced cargo liners, passenger/vehicle ferries, coastal cargo vessels, sludge vessels and dredgers

(4) Marine biological research ships, seismographic research ships, and fisheries research vessels.

Y-ARD has carried out economic studies related to ship operational cost data, modernisation and automation of ship repair yards, ship building cost estimates, market survey of shipping built world-wide, survey to predict future shipping trends and prediction on the demand for future types of ships, market surveys of marine equipment, and economic study of factory trawler ships.

Y-ARD has undertaken studies relating to the fishing industry, including the examination of fishing gear equipment, evaluation of fish-finding methods and the handling and processing of catches which have included methods of chilling and freezing.



MV *Maihar,* Cunard-Brocklebank Line

Naval consultancy

Technical services

Weapon and electric systems

Y-ARD offers a complete weapons and communications system engineering service. The service embraces the selection, installation design, and post-design of all surface and oversurface weapons, fire-control radars and computers, surveillance and attack sonars with their associated weapons, surveillance radars, navigational aids, communications, action information systems and electronic warfare equipment.

Special features of the service include:

(1) The integration of the systems to meet a defined threat by statistical analysis methods and the assessment of the hitting and killing probability of the systems
(2) The comparison of competing weapon systems
(3) Periodic maintenance, testing and tuning of weapon and communications systems on a world-wide basis.

Naval architecture

A complete naval architecture service is provided, including survey of ships, inclining experiments, the estimation of static, dynamic and damaged stability, performance estimates, investigation of hull vibrations, the design of stabilisation systems, etc. Y-ARD represents the British Trawler Federation on the International Maritime Consultative Organisation's panel on the stability of trawlers.

Controls and simulation

Y-ARD has wide experience in the design of automatic control systems for equipment of all sorts, and a comprehensive knowledge of the equipment available both in the UK and elsewhere. Since Y-ARD is not tied to any particular manufacturer it can offer to clients an optimum overall system design using the best equipment available.

The common factor to all work on control systems is the need to understand the basic mathematical relationships.

One of the most effective methods of achieving this is simulation, and Y-ARD's recent purchase of an EAL 680 computer has greatly increased the complexity of systems which can be simulated. Complete systems can now be simulated, with actual control equipment attached to prove the effectiveness of the system before it is installed on the plant.

Simulation is also a valuable technique on its own account, particularly for the investigation of problems which are too difficult, too dangerous or too expensive to solve by other means.

Actual controls equipment for a ship is connected to a hybrid computer for testing to determine the correct controls settings.

Acoustic studies

Y-ARD's experience of the isolation of noise and vibration from ship's structure and the protection of equipment from underwater shock includes the development of novel types of vibration-isolating mountings, shaft couplings, pipe couplings, and shock-absorption devices of high capacity. Design services offered include the design of acoustic enclosures, theoretical estimates of vibration of shafting systems, structural and stress analysis of components liable to damage by fatigue or shock, and the writing of specifications. Practical services include the survey and analysis of airborne and structure-borne vibration, diagnostic investigations, and the development of various types of equipment.

Y-ARD LIMITED
PO Box 4000, 1395 South Street, Glasgow W4, Scotland
Telephone: 041-959 1251 Cables: Yard Glasgow Telex: 77380

Y·ARD

Technical documentation

for the armed services

IPL (Gardener) Ltd is a member company of the IPL group, one of the leading technical documentation organisations in the United Kingdom. The group provides a very wide range of technical information support services for government departments, defence authorities, industry and commerce.

The company is a contractor to the British Ministry of Defence, Ministry of Technology, Department of Health and Social Security, and to Her Majesty's Stationery Office (HMSO).

Communication

Written material remains an essential element but an important ancillary activity is the preparation of slides, filmstrips, mimic diagrams together with programs for teaching machines and software for computers. The accelerating development of complex equipments for use by the armed services brings with it a really serious problem in training service personnel to use and service the equipment correctly. Most of the resources of modern communications techniques are required to provide a solution.

The problem

Manufacturers invariably do not wish to become directly involved with the compilation and production of after-sales technical documentation such as operators handbooks, training manuals, illustrated spare parts catalogues, NATO codification, security printing, and visual training aids.

The solution

Many manufacturers now utilise the services of a company specialising in technical documentation support services. Ours is a company staffed by engineers, authors, illustrators, NATO codifiers, with adequate translation facilities and with a print works capable of handling security work.

Technical authorship

We can provide technical authorship dealing with every branch of mechanical and electronic engineering and with scientific development. Our service includes the study, planning, writing and supervision of publications giving operating and maintenance information reports; we can also prepare illustrated parts catalogues.

Technical illustrations

Technical illustrating, comprising all kinds of line drawing, half-tone and retouching perspective exteriors and cutaway views, exploded drawings and simplified or schematic presentation of systems are all carried out by our illustrators.

Circuit diagrams

Circuit, wiring and component location diagrams can be prepared to meet the requirements of issued government and commercial specifications.

Typing and typesetting

We can undertake the typing of technical copy suitable for litho reproduction, including cold type-setting, justified where required.

Reproduction

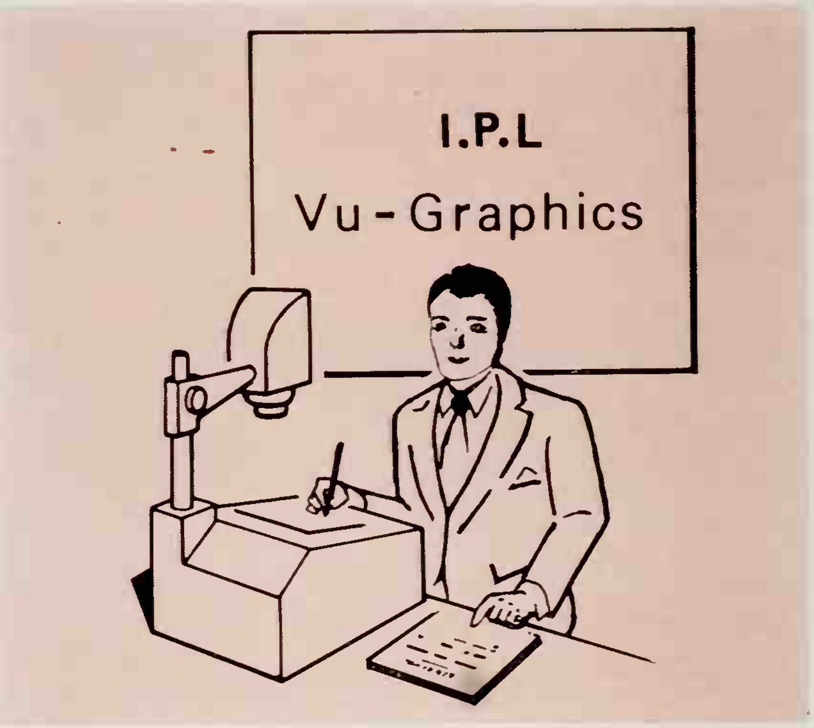
We also carry out reproduction by offset litho or other processes, suitable for short medium and long runs, as required.

NATO codification

Identifying, classifying and coding items of defence supply to the NATO classification and coding system is carried out. We are proficient in the use of various 'tools of management' (H61—Glossary of Terms, etc) required to determine item characteristic attributes necessary to eliminate duplicate stock holding and to ensure items of defence supply are allotted the correct RP/DP.

Visual-aided technical training

Modern complex equipment requires supporting technical documentation be presented simply but clearly, and in a form suitable for classroom presentation. Overhead projectors present the subject in a manner easily assimilated by the student and offers greater control over a lesson's progress. Greater visual impact is provided by transparencies—single or multi-coloured. We can provide single sets or runs of many thousands, plus paper print for student handout. This system is a completely universal training aid both in subject content and (using translation overlays) language.



IPL (GARDENER) LIMITED
Government Marketing Division
Codex House, Willow Grove, Chislehurst, Kent, BR7 5DA, England
Telephone: 01-467 5633

IPL GROUP OF COMPANIES

Jane's yearbooks

four international annual reports

Jane's annual reports are known and respected throughout the world not only by individual experts, but by professional naval, military and airforce personnel and government departments as well. All relevant information is presented in concise up-to-date form and the yearbooks are regarded as standard reference works on the present state of their respective fields by many authorities throughout the world. Entries in all four yearbooks quote standardised specifications and performance data; dimensions are in British and metric units. Most entries are illustrated.

Jane's All the World's Aircraft

Regular contents are all continued in the 1969–70 edition:

DESCRIPTIVE SECTIONS

Complete specifications with photographs, and in many instances three-view drawings, of current production in the aero-space industries:

Aeroplane section: civil and military, including V/STOL

Drones section: all powered but unmanned aircraft

Gliders and sailplanes section: the products of 22 countries

Space vehicles section: capsules and satellites with their rocket propulsion systems

Rocket weapons section: specification of all types for all defence purposes

Aero-engines section: all aero-engines in current production—turbine, piston or rocket

New features introduced with this issue:

DIRECTORY SECTIONS

Aircraft accessory and equipment manufacturers section: address, products and national agents, with individual product cross-references

Airports section: officials, major runway details, maintenance organisations

Airline sections: present and planned fleets: officials and branches

DESCRIPTIVE SECTIONS

Aircraft radio and radar section: specifications and illustrations, listed under manufacturers

Airport ground equipment: specifications, with photographs, of all types of ground equipment, manufacturers, addresses and branches

Jane's Weapon Systems

The contents of the first edition for 1969–70 include:

DESCRIPTIVE SECTIONS

Weapon systems section: each system described and illustrated as a whole, with operational procedures. Detailed specifications and illustrations of elements peculiar to one system, otherwise elements are cross-referenced to

Elements section: guidance and surveillance elements, and other electronic equipment, propulsion units, sea-, air-, or land-borne vehicles, support equipment, each described and illustrated in sub-sections, and cross-referenced to weapon systems in which they are selectively used

ANALYSIS SECTIONS

Purpose analysis section: an extremely detailed series of indexes, with explanations, that classify the design, tactical and operational purpose of each element of each type and of each weapon system, so allowing comparative analysis

National and supra-national defence forces' equipment: catalogues of service command structures, quantitative data on their current equipment and location

Jane's Fighting Ships

Regular contents are continued in the 1969–70 edition:

DESCRIPTIVE SECTIONS

National navy sections: the 103 navies are presented in alphabetical sequence, more than 14 000 ships being set out, country by country, in order of purpose and size

Each country's section commences with brief administrative details, a listing of the navy's strength and silhouette drawings of the principal ships

This is followed by illustrated descriptions and specifications, category by category, of all the vessels in naval service from major warships right down to tugs

Naval aircraft: all ship-borne aircraft and helicopter types are described with data, and illustrated with photos, and land-based naval reconnaissance aircraft are similarly described

Ship-borne missiles: all types of naval missiles are described and illustrated, under operational-purpose classifications

ANALYSIS SECTION

Naval strength: comparative tables for the principal naval powers

New features introduced in this issue:

DIRECTORY SECTIONS

Command structures: Naval staff lists, headquarters, dockyard, and support, and sea staff

Naval who's who: an attempt at abbreviated essential particulars of senior naval personnel

Jane's Surface Skimmer Systems

The contents of the 1969–70 edition include:

DESCRIPTIVE SECTIONS

Air-cushion vehicles: over 70 types are now in production or projected by over 40 manufacturers in a dozen countries. Full dimensions, operational descriptions, and performances are given

Tracked ACVs: the development of ACV trains taking place in several countries is reported

Air-riding materials-handling: a commercial by-product of the ACV inventions. Detailed specifications of apparatus with photos and drawings are included under two sections: 'Air-assisted pallets, conveyors and applicators', and 'Air-assisted load carriers'

Hydrofoils: both Service and commercial uses for hydrofoils of varying tonnages are rapidly commanding sizable production by specialised shipbuilders. There are already 70 types in production in a dozen countries, with over 1000 hydrofoils in regular service in the USSR. Data are detailed, and include sea-state capabilities, and experience of operators

Power plant: specifications of all types of engines, marine or aero-industry derived, used in ACVs and hydrofoils

SURVEY SECTIONS

Report of ACV development
Report on hydrofoil development
Technical glossary (illustrated)
Design problem papers

JANE'S YEARBOOKS
BPC Publishing Limited
49 Poland Street, London, W1A 2LG, England
Telephone: 01-437 0686 Telex: 23451

Documentation

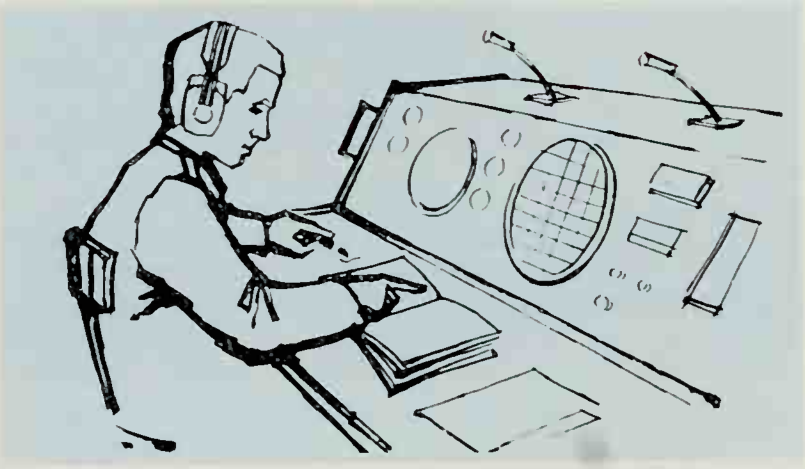
to ensure maximum utilisation of equipment

Users of defence equipment, particularly those at a distance from the factories of the manufacturers, need complete technical information to ensure that the equipment can be operated and maintained by their own personnel. This information takes the form of technical handbooks, drawings, operating and maintenance manuals, installation and commissioning specifications, spares catalogues, microfilm libraries, training manuals and training aids, wall charts, etc.

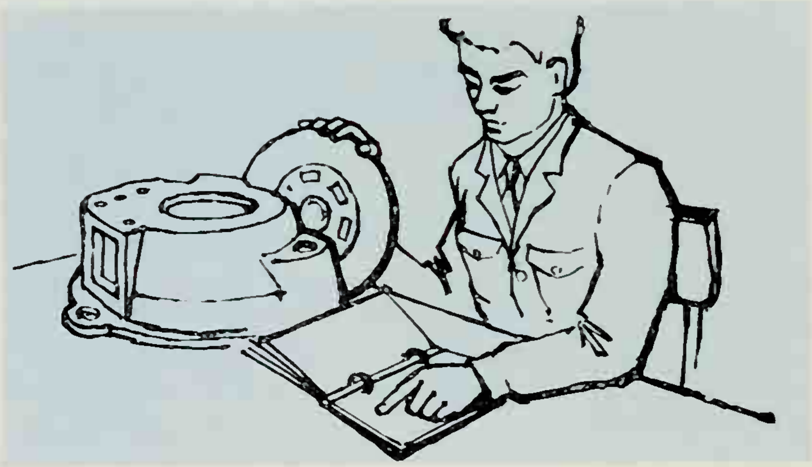
Such documentation is produced for the British armed services and may be available for other countries, but documentation produced specially for the user's requirements is far more effective. This incorporates up-dating with technical modifications, so that documentation is entirely relevant to the equipment purchased. It takes into account aspects such as local language, different technical symbols, methods of deployment, climatic conditions, maintenance facilities and available test equipment, spares policy, and the educational level of trainees.

Lonsdale and Bartholomew Technical Ltd has 20 branches in the industrial centres of the UK for ease of liaison with manufacturers. It has already produced documentation and drawings for all types of defence equipment in use with the armed forces of Britain and many other countries. Information systems already in existence have been modified for the methods and organisation of new users.

Typical applications


Operating instructions produced specifically to suit your particular equipment and organisation

Training manuals and aids enable trainee operators and technicians to become proficient quickly


Maintenance instructions clearly and precisely presented ensure trouble-free operation of equipment

Spares catalogues and schedules carefully prepared to assist the rapid procurement and supply of spares. NATO Codification of Spares and other items are included in these publications

Among the technical services available, either separately or as part of complete documentation schemes, are the following:

Technical authorship
Technical writing
Technical editing
Illustrations of all types
Design and detailed production drawings
Spares scheduling
NATO codification
Component specification and advisory services
Data processing
Printing

LONSDALE & BARTHOLOMEW TECHNICAL LTD
86–88 Edgware Road, London W2, England
Telephone: 01-723 8001

Support services

in shipbuilding and naval service

Various support services are available to overseas countries purchasing or building warships such as the Type 42 destroyer. The need to ensure maximum operational availability and value for money over the whole of a ship's life has led to an increasingly close liaison between customer and shipbuilder over a widening area of activity.

Technical aid

The needs of overseas countries wishing to establish their own shipbuilding programmes can be handled by a technical aid organisation such as that established by Vickers in 1965 to guide the construction of three Leander Class frigates in India. Technical aid agreements typically include advice on shipyard layout and equipment, provision of ship drawings and documentation, procurement of equipment, planning, and assistance with setting-to-work.

An important feature of technical aid is the provision of technical and supervisory staff, and training of all levels of shipyard personnel. The latter includes on-the-job training and specialist courses in the UK, followed by training and supervision during construction in the customer's own shipyards.

Technical aid agreements normally cover a wide range of services. In some cases, however, only one or two services may be required, such as quality control or equipment procurement. All the services may be made available overseas or within the UK to other shipbuilders. Lead yard services, similar to those provided on the Polaris submarine and Type 42 destroyer programmes, can also be provided in support of shipbuilding contracts external to Vickers.

Operational training

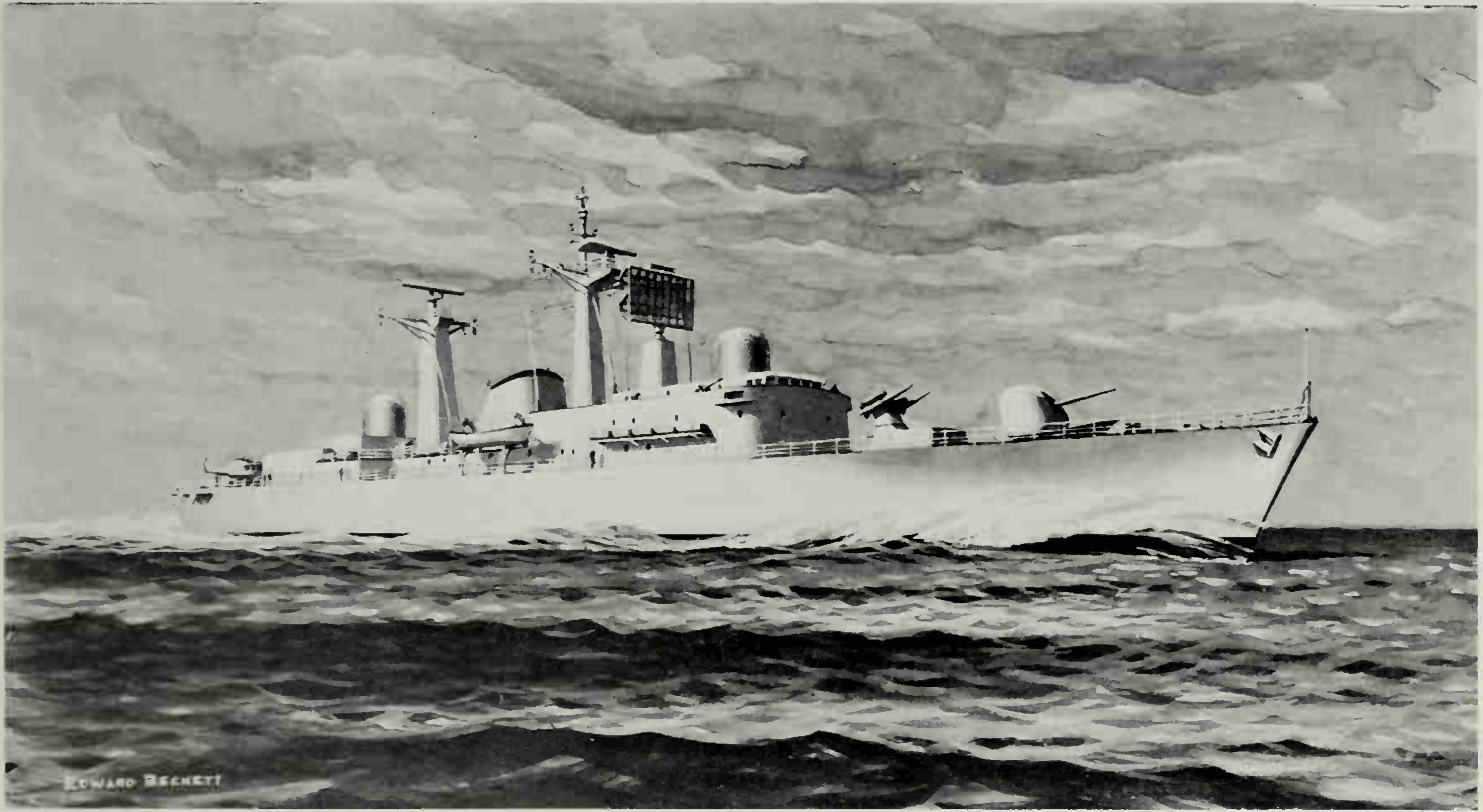
Crew training, carried out by the customer navy, is increasingly integrated with the ship construction and setting-to-work programme. This integration can be undertaken by Vickers on behalf of a customer, covering areas such as:

- Definition and co-ordination of training programme (in conjunction with the British Ministry of Defence as appropriate)
- Colloquial language training
- Arrangement for training at British Ministry of Defence establishments, sub-contractors' works, and shipbuilders' works
- Training during installation and testing

Other specialist services

Other specialist services offered by Vickers include:

- Weapons systems consultancy and evaluation
- Weapons system tuning and test
- Maintenance, operating and training documentation
- Reliability and maintenance studies
- Refit planning and documentation



The first Type 42 destroyer (described elsewhere in this Catalogue) built by Vickers will soon be in service with the Royal Navy

VICKERS SHIPBUILDING GROUP
Barrow Shipbuilding Works
PO Box 6, Barrow-in-Furness, Lancashire, England
Telephone: Barrow-in-Furness 20351 Cables: Vicarmsea Barrow-in-Furness
Telex: 6571

Vickers

Design, development and production of electrical and electronic equipment

We produce electronic test gear microwave components and equipment incorporating electrical and electronic wiring and assembly, semi-conductor and other circuitry, and sheet metal work; we also carry out general machine work, welding, brazing and processing to customers' requirements.

For the above work the company has approval under the British Ministry of Technology Inspection Organisation (No. 60077).

Standard commercial products include constant-potential battery chargers, timing delay units voltage and frequency-detection units, and surge indicators.

Erskine Laboratories Ltd
Newby, Scarborough, Yorkshire, England
Telephone: Scarborough 2433
Cables: Erskinlab Scalby
Telex: 52562

Special-purpose mechanical and electro-mechanical equipment

This company has for many years been a Ministry of Defence contractor for varied types of equipments, including recorders, gunnery controls, handling gear, sonar devices, time clocks, test gear and similar items for which drawings and specifications are available.

In manufacturing similar units for recognised foreign governments and on a sub-contract basis for large contractors, we have the full co-operation of the British Ministry of Defence.

We are willing to consider the manufacture (even in small quantities) of any equipment for which drawings are available.

Samuel Lee-Bapty Ltd
Cow Lane, Garston, Watford, Hertfordshire, England
Telephone: Garston 73055

Rocket motor systems, solid cast double base propellants

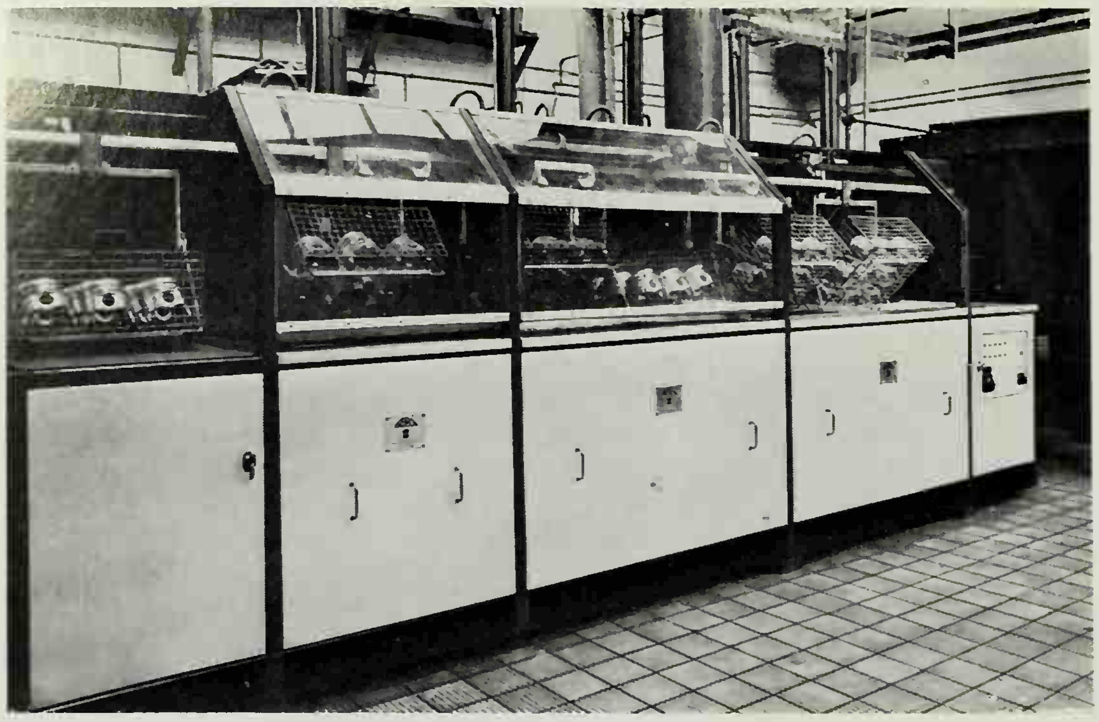
Solid propellant rocket motors using cast double base propellants are designed, developed and produced to customers' requirements. Related research and development is carried out. SRS is fully equipped to carry out firing, environmental and mechanical tests on rocket motors from 5 mm to 930 mm in diameter.

Rocket devices, such as igniters and thrust vector control systems, are also the subject of research and development. Successful systems are in use in UK guided missiles. Rocket cases are designed and developed using metal, glass-reinforced plastics and carbon fibre-reinforced plastics.

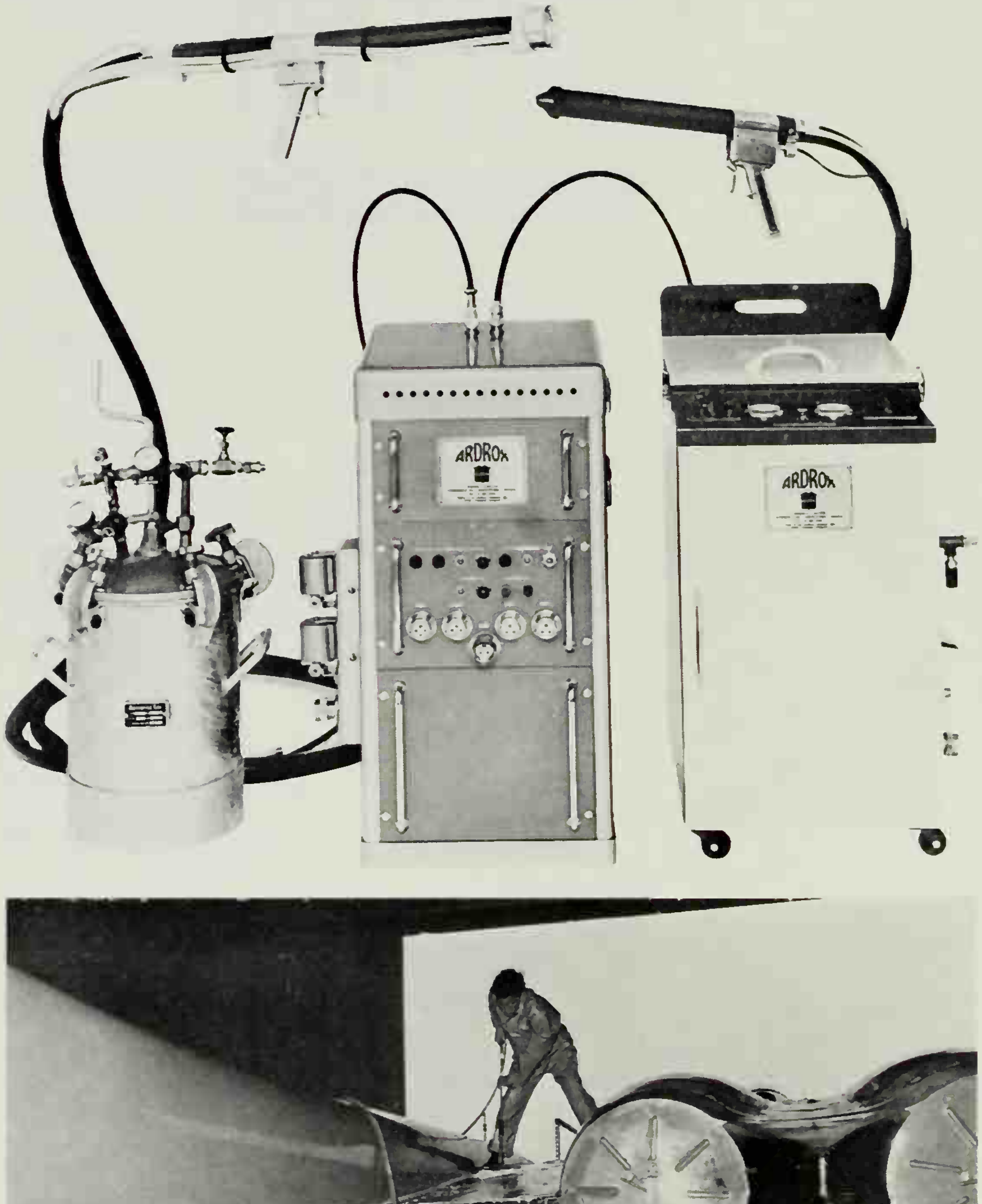
Summerfield Research Station
Imperial Metal Industries Ltd Kidderminster, Worcestershire, England
Telephone: Kidderminster 4061
Telex: 33527

Section 39

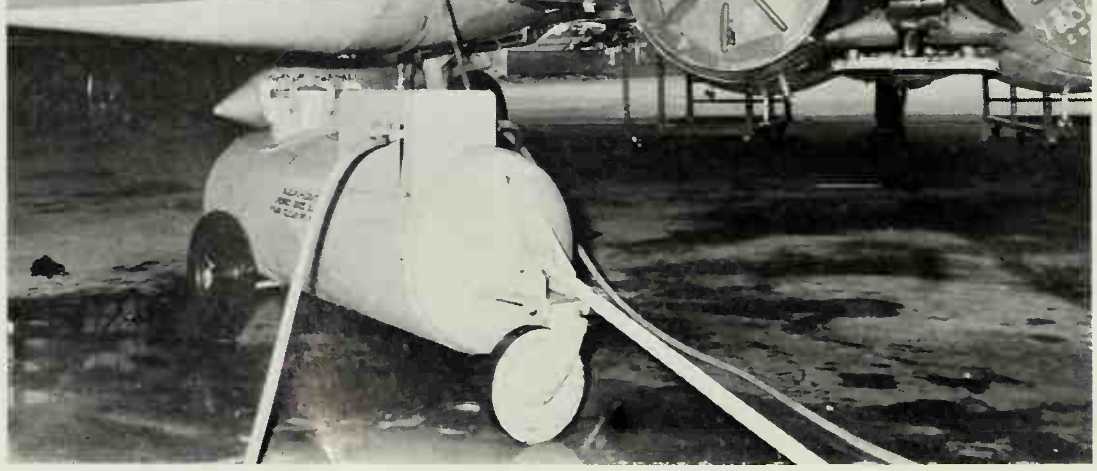
Other products and services



Automated flaw-detection plant installed at Wellworthy Limited for the programming of pistons through one of the Ardrox 970 processes



Ardrox Speedspray electrostatic equipment for the application of fluorescent penetrants and dry powder developers to large aero engine components



Ardrox foam cleaning equipment, utilising 6025.AF for aircraft surface cleaning

Chemicals and equipment

for surface treatment, cleaning and flaw detection

Ardrox Limited has manufactured specialised cleaning and flaw-detection materials and equipment for all branches of the British Ministry of Defence for many years, including proprietary products and compounds made to Government specifications. All are available in most countries through a network of associated companies, manufacturing licensees and agents. The services of our technical department are available to advise on the suitability of any particular process wherever special problems are likely to be encountered.

The products described below represent some of the range available, together with the relevant specifications and NATO or British Government Stores reference numbers.

Rust, scale, oxide and corrosion removers

Preparations for the removal of rust, scale, oxide and other corrosion products are available for the dip-cleaning of all kinds of ferrous and non-ferrous metals.

Ardrox 11A: acid de-ruster used by Royal Navy armament depots for de-rusting torpedoes. Stores Ref No 435389

Ardrox 185: approved to DTD/900/4559. Alkaline de-ruster used by Royal Navy aircraft repair yards and approved by aero engine manufacturers for the overhaul of gas turbine engines. Stores Ref No 0473-473005

Ardrox 1074: approved to DTD/900/4934. Acid etchant used by the Royal Air Force and Royal Navy Air Stations as pre-treatment for aluminium-skinned aircraft prior to painting. Stores Ref No 0473-6850-99-220-1932 (RN); 33C/2204099 (RAF)

Ardrox 1854: liquid concentrate alkaline de-ruster used extensively in British Government dockyards for a variety of de-rusting, de-painting and degreasing tasks. Stores Ref. No 0473-220-1713

Ardrox 160: acid-based corrosion remover and brightener for copper-based alloys. Used extensively by British Government dockyards for cleaning pipework systems where a high standard of cleanliness is required. Stores Ref No 0474-220-1162.

Degreasing, decarbonising and immersion-type paint removers

A special range of solvents has been developed for the removal by dipping of all types of paint, grease, carbon and similar coatings and deposits from external and internal surfaces.

Ardrox 607: approved to DTD.445A. Concentrated general-purpose solvent emulsifier used in British Government dockyards in dilution with kerosene as light-duty degreasant and by Royal Navy Air Stations for aircraft surface cleaning. Stores Ref No 0474-474006

Ardrox 610-C: heavy-duty concentrate degreasant used by British Government dockyards for IC engine overhaul. Stores Ref No 6850-99-220-2570

Ardrox 667: concentrated immersion-type paint and carbon remover used by British Government dockyards for internal combustion engine overhaul in combination with 610-C. Stores Ref No 0473-220-2779

Ardrox 960-T: approved to DEF.1451. Hot-bath immersion-type paint and carbon remover supplied to British Army units and British Government dockyards. Stores Ref No 0474-6850-99-220-2315

Ardrox 6025.AF: approved to DTD.5507B. Supplied to the Royal Air Force, Royal Navy Air Stations, and Army Air Corps for aircraft surface cleaning. Used by British Government dockyards for cleaning of machinery and electrical equipment. Stores Ref Nos 5 gal—0474-220-4399; 40 gal—0474-220-4400

Application-type paint removers

A special range of application-type solvents to strip paint and surface coatings of all types from structures too large to be dipped.

Ardrox 204: approved to DEF.1280B. Paint remover for epoxy-based paint schemes used by the Royal Air Force and Royal Navy Air Stations. Stores Ref No 5 gal—33B-9429-260; 10 gal—33B-220-1083

Ardrox 217: approved to DEF.1279. General-purpose paint remover supplied to British Government dockyards and British Army units. Stores Ref No 1 gal—0473-4148; 5 gal—0473-7972

Ardrox 230: approved to DEF.1443. Special paint remover for use on polyester resin/glass laminates. Used by Royal Air Force, British Government dockyards and Royal Navy Air Stations. Stores Ref No 0442-923-1717

Protective and dewatering oils

Ardrox preparations are available for the long-term or short-term protection of various types of equipment against corrosion attack by atmospheric moisture and seawater.

Ardrox 31: conforms to DEF.2331 (PXI undyed). A lanolin-based protective fluid for use on all unpainted metal components where long-term indoor storage is required.

Ardrox 3961: conforms to PX24. Approval DEF-STAN 68-10/1. Moisture-displacing fluid and temporary protective for electrical equipment, the compressor stages of gas turbine engines and all surfaces requiring thin-film protection against atmospheric and saltwater corrosion. Used by the Royal Air Force, Royal Navy Air Stations and British Army units. Stores Ref No 1 gal—34B/1480.

Dye penetrant inspection processes

All Ardrox dye-penetrant processes meet the requirements of DTD.929 and MIL-I-25351C. A complete range of red, combined red-and-fluorescent, and fluorescent types are available, including water rinsable and post-emulsifiable types.

Ardrox 996 process: high-sensitivity red dye system—also available in aerosols. Stores Ref No 996-P Aerosols—4X-2420; 9PR551 Aerosols—4X-2421; 9D6 Aerosols—4X-2422; Aerosol kit complete—4X-2419

Ardrox 9VF1 process: combined high-sensitivity red and low-sensitivity fluorescent system—specially developed for use on submarines and in other confined spaces. Also available in aerosols.

Ardrox 970 group: includes various types of water-rinsable fluorescent penetrant systems, each having different responses to rinsing and levels of sensitivity.

Ardrox 985 group: includes various types of post-emulsified fluorescent penetrant systems each having different levels of sensitivity.

Flaw detection equipment

Automated penetrant inspection plant: for the accurate processing of small components such as turbine and compressor blades from gas turbine engines. Plants have been supplied to Royal Navy aircraft repair yards, aero-engine manufacturers, airline operators and component manufacturers in the motor industry.

Amlec crack detector: eddy-current crack detector developed by the Admiralty Materials Laboratory for the high-speed checking of long runs of continuous welds. Chosen by the British Ministry of Defence (Navy) for use in dockyards and ships.

Magnetic particle inspection fluids

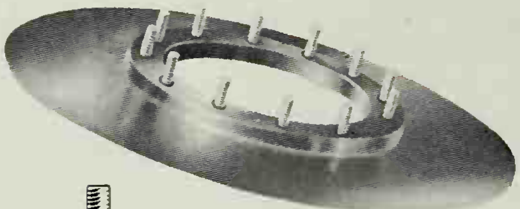
A complete range of black, red and fluorescent magnetic particle inspection fluids is available. All Ardrox magnetic particle inspection fluids conform to the requirements of British Standard 4069. Stores Ref No Ardrox 800/2—4A/2440.

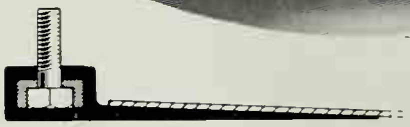
ARDROX LIMITED
Commerce Road, Brentford, Middlesex, England
Telephone: 01-560 5444 Cables: Ardrox Brentford Telex Telex: 23609

ARDROX
SURFACE
TREATMENT
CHEMICALS

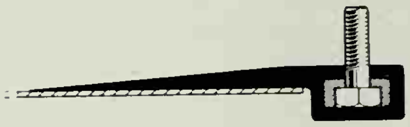
Installing a Hycatrol flexible tank

MOULDED BOLT-RINGS

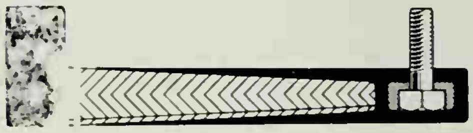




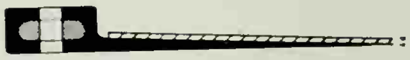
A-Type (7901 series)



A-Type (8018 series)



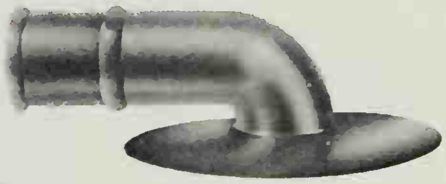
A-Type (double-flanged)



A-Type (no-bolt)

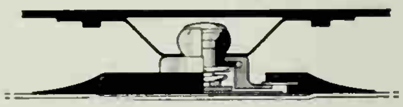
MOULDED RUBBER CONNECTORS

7165 series



7041 series

SUPPORT METHOD



Spring-colleted stud (half-section) in metal dishing

1—Hycaflex material is used for hovercraft skirts

2—Emergency flotation gear fitted to helicopters

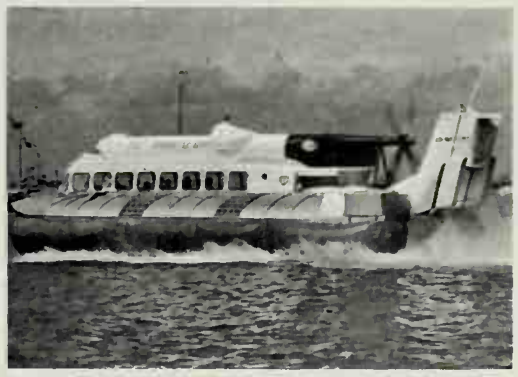
3—18 litre (4 gal) Jerribags for drinking water or fuel

4—Board of Trade approved 4 m (13 ft) inflatable workboat

5—Automatic self-sealing fuel coupling fitted in the *Sioux* helicopter

6—Effluent coupling for standard 100 mm (4 in) aircraft connection

1



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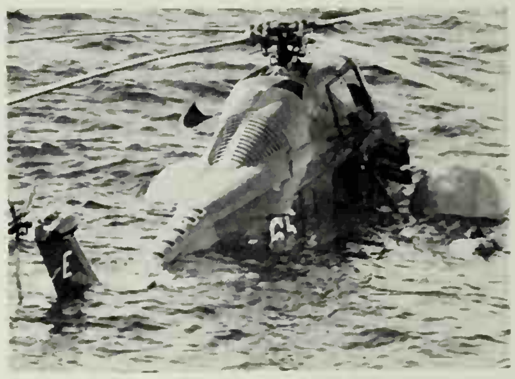

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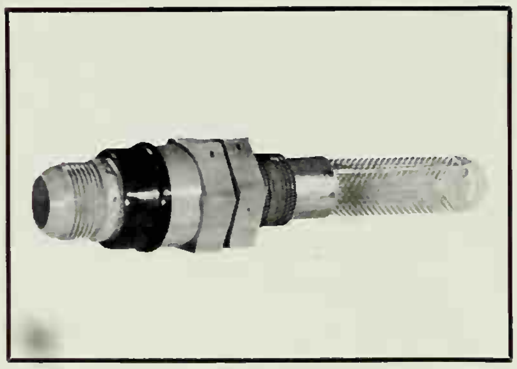


6

Flexible assemblies

for liquid storage and flotation

Hycatrol tanks

The flexibility and shock-resistance of Hycatrol fuel tanks have, for many years, provided additional safety in both military and civil aircraft. These tanks are fully approved by the Ministry of Technology and are manufactured from a lightweight, high-strength, fuel-resistant synthetic rubber, reinforced with nylon fabric. They can be tailored to fit compartments enabling all available space to be used and give many years of dependable life.

Hycatrol has excellent ozone-resistant properties and is now used for the fuel tanks in air cushion vehicles where high resistance to fatigue, shock and corrosion is required.

Many land vehicles are fitted with Hycatrol tanks and boat designers are also fitting this type of tank into power boats because of its ability to meet the severe conditions encountered at sea.

Leading makes of Grand Prix and other racing cars have, for many seasons, been using Hycatrol fuel tanks owing to their high crash resistance and because they help to eliminate metal fatigue.

Hycalam tanks

The latest addition to the range of flexible tank materials is Hycalam, a laminated material specially designed to meet the requirements laid down in the American specifications MIL-T-6396 (Military) and FAA.TSO-C.80 (Civil). This material is fully approved by the Ministry of Technology and the Air Registration Board. It has a very high tensile strength/weight ratio, high resistance to puncture and tear, excellent fuel-resistant properties and low permeability to all grades of petroleum fuel.

Hycalam is available in single, two-ply or three-ply laminates.

Self-sealing coverings

Hycatrol and Hycalam tanks in military aircraft can be covered with a self-sealing material which minimises fuel leakage in the event of penetration by small shell fragments and by ball ammunition up to 12·8mm (0·5in) calibre.

Two grades are available, FPT/442/LS, a lightweight covering giving protection from penetration up to 7·7mm (0·303in) and FPT/446/LS, a slightly heavier grade to prevent leakage after penetration of up to 12·8mm (0·5in). Both grades of covering are fully approved by the Ministry of Technology and are extensively used on aircraft of many different types.

Hycaflex inflatables and associated products

Hycaflex is a range of strong but lightweight rubber/fabric/rubber laminated material that is used for the manufacture of inflatable products. The thickness of the material, the type of fabric and the grade of rubber used is dependent on the application of the product.

Hovercraft skirts and skirting materials

Similar material is used for the manufacture of hovercraft skirts. All British Hovercraft Corporation craft and many others are fitted with Hycaflex skirts in thicknesses ranging from 0·254 to 0·381 mm (0·010 to 0·150 in) and weights from 0·34 to 5·0 kg/m^2 (10 to 150 oz/yd^2).

Flotation equipment

Among the most important are the emergency flotation bags fitted to helicopters, especially those employed on air-sea operations. These lightweight inflatable bags are operated instantly either manually or automatically by saline switches.

Helicopters are also fitted with inflatable pontoons which are fixed to the port and starboard undercarriage as the main landing gear. These pontoons can also be fitted on aircraft engaged on over-water operations.

Inflatable workboats

The Hycaboat FT130 is a 4 m (13 ft) inflatable workboat built to British Board of Trade approval, manufactured from a Neoprene/nylon/Neoprene material only 1 mm (0·040 in) thick but able to withstand a considerable amount of hard usage. Development of a 4·9 m (16 ft) version is in hand.

Among the smaller Hycaflex products are the 4-gal (18-litre) Jerribags for drinking water or fuel; these are made from toxic-free or fuel-resistant materials. The Jerribags are light, fully flexible and can be rolled up for easy stowage when empty. Fresh-water Jerribags are blue in colour; the fuel quality ones are green.

Associated equipment

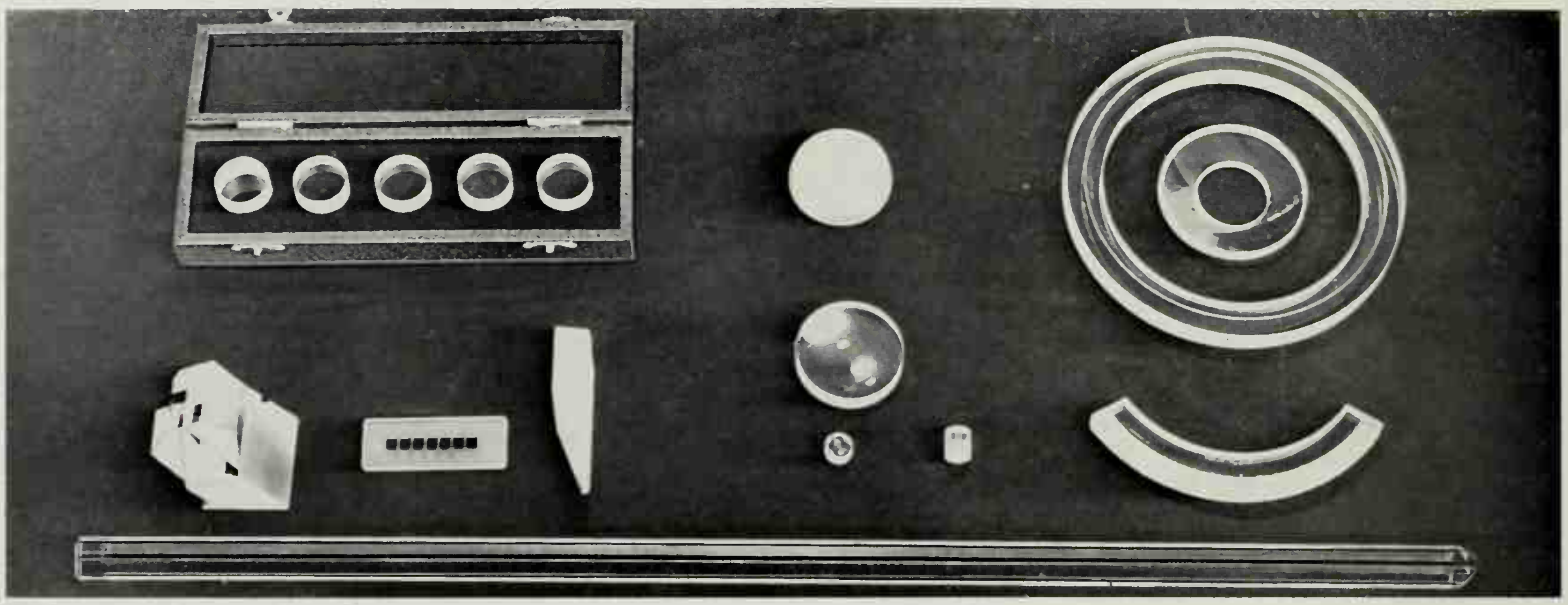
Associated with Hycatrol, Hycalam and Hycaflex products are other smaller but equally important goods. The automatic break-away coupling was specially designed for the fuel system of the Sioux helicopter as a safety device when the aircraft is on operational duties. The use of the coupling is not restricted to the Sioux but can be used in any fluid systems which are liable to sudden stresses or excessive axial loads. A variant of this coupling is used as a safety device in the oxygen supply line for pilots of military aircraft.

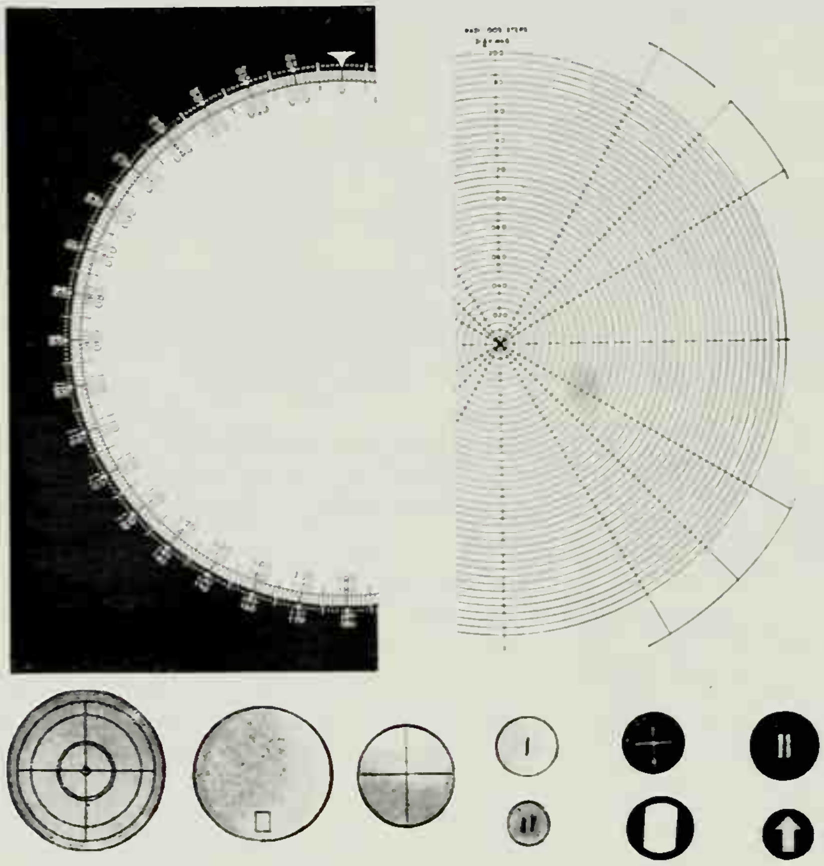
Another product is the rubber-bonded effluent coupling which was designed in conjunction with BOAC, for use on the standard 100 mm (4 in) dia effluent connections on aircraft. This ground equipment coupling is manufactured from stainless steel, reinforced externally with compression-moulded Neoprene rubber.

FPT INDUSTRIES LIMITED
The Airport, Portsmouth, Hampshire, PO3 5PE, England
Telephone: Portsmouth 62391 Cables: Fireproof Portsmouth Telex: 86106

Optical elements

and optical equipment





Above: Typical unmounted optical components, including lenses, prisms, gauges, scales and a laser rod (bottom)
Left: A few of the scales and graticules made to suit special requirements
Below: Type E pantometer for comparing the contour of precision components projected on to a screen with a tracing of the required contour magnified 10 ×

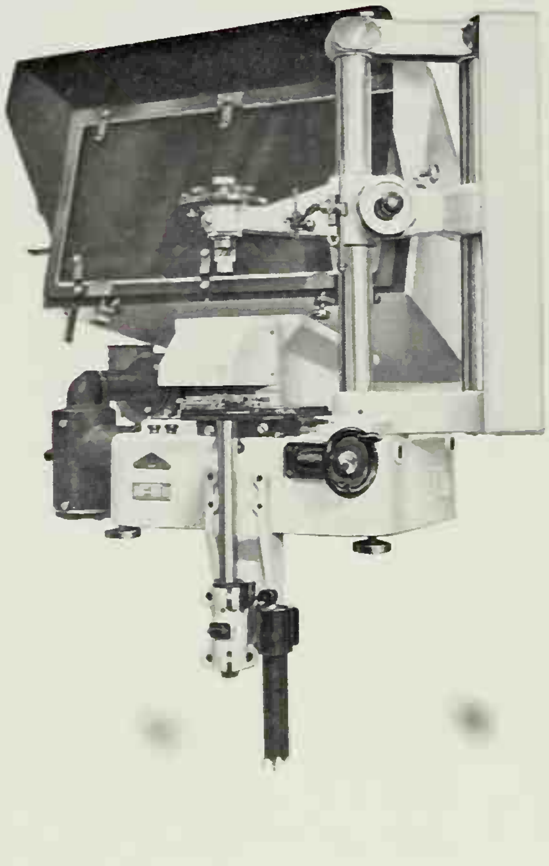
Optical components of any kind (flats, lenses, prisms and compound elements) and of any optical material (glass, natural and fused quartz, synthetic and metal) can be made by Optical Measuring Tools Limited to an accuracy of 0·00002 mm (0·000001 in) and with angles correct to 1 second of arc.

Highly skilled specialist staff and unique special-purpose equipment housed in strictly temperature-controlled rooms are employed. A wide range of optical flats, dimensional and angular gauges are available as standard. Special types, as well as optical elements of all types, for sights, telescopes, view-finders, navigating and similar equipment can be made to order. The company also offers an advisory and computation service for the design of all types of optics and optical systems.

Ruby and other crystals can be worked into rods for solid-state lasers and metal components can be polished to optical finish. The company also has a high-vacuum laboratory for surface-coated mirrors, anti-reflecting coatings, multi-layer films, electrically conducting coatings, neutral filters and similar work.

OMT also specialises in the manufacture of graticules, scales, diffraction gratings and moiré fringe pairs. In fact the company has been appointed by the National Research Development Corporation as official manufacturer of master linear and radial diffraction gratings for ultra-precision measurement and numerical control equipment. OMT is also approved by the National Engineering Laboratory to make and supply dimensional standards and scales as masters to other manufacturers of measuring tools and equipment.

In addition to optical elements, OMT also makes a wide range of toolmakers' microscopes, optical comparators, precision projectors, measuring machines and optical dividing heads, rotary indexing tables (shown opposite) and projection-type pantometers, one of which is illustrated here. Other standard units range from a bench pantometer with 30 × magnification on a 152 mm (6 in) dia screen to a universal projector with up to 100 × magnification on to a 1524 × 1016 mm (60 × 40 in) screen.



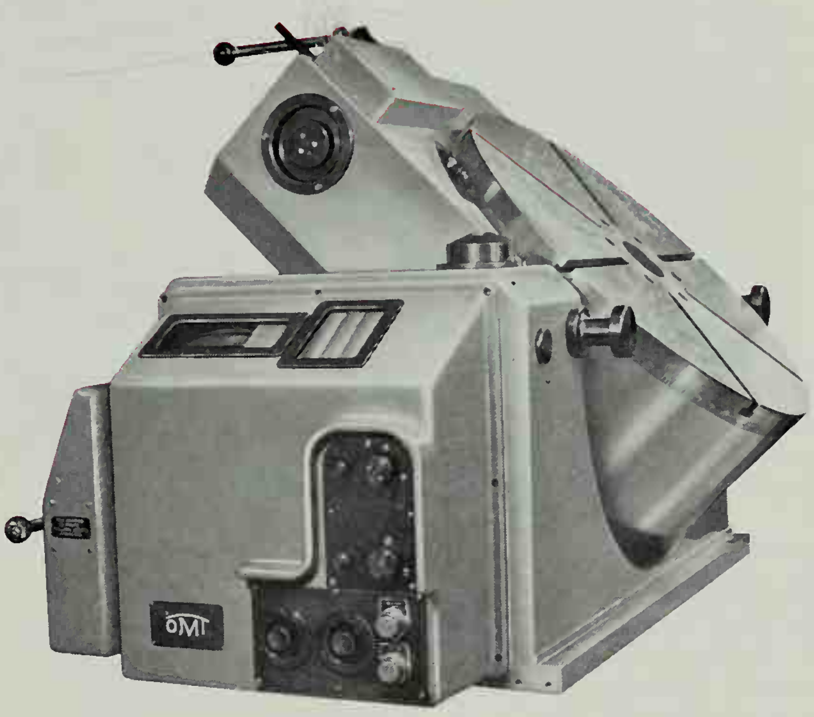
Rotary indexing tables

with manual and automatic drive

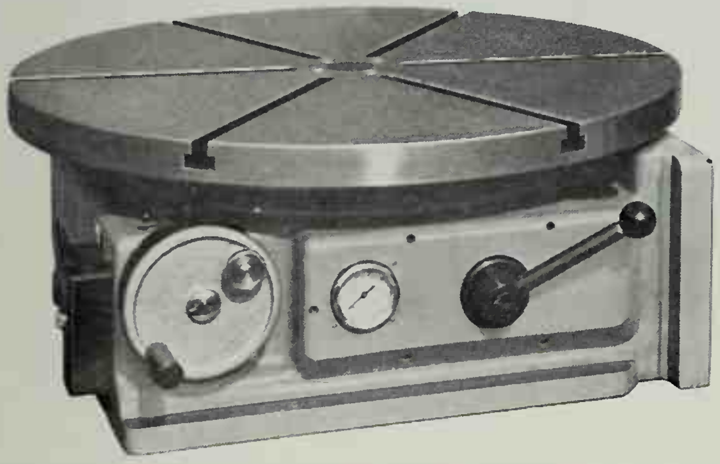
Accurate angular positioning is one of the most exacting metrological tasks and Optical Measuring Tools Limited has specialised for many years in the design and manufacture of precision equipment for angular location in one plane or two planes simultaneously. With rotary tables up to 1067 mm (42 in) diameter, positional accuracy up to ±0·001 degree, repeatability up to 0·0003 degree and load capacity up to 2 tons, with optical or digital readout, with manual or power drive, with or without fully automatic tape control, the range is ideally suited for precision machining, graduating scales, inspection and test purposes of all kinds, including the calibration of gunnery scales.

The units are so designed that no part of the body projects above the surface of the platen, thus enabling work considerably larger than the platen diameter to be mounted on the table. The working surface and base are plano-parallel to within 0·005 mm (0·0002 in) on all models. The dual-purpose models have a second mounting surface at right angles to the base, thus enabling these tables to be used in both the horizontal and vertical position.

Presetting drives and remotely located digital readout units are available as standard. Equipment suitable for integration with computer-controlled systems can be made to suit special requirements.



Above: Power-operated rotary table with adjustment in two planes and optical readout



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NEWALL

Left: Manually operated rotary table suitable for vertical or horizontal use, shown here with remote digital readout unit

Model†	Read-out††	Platen dia		Drive†††	Scale		Motor hp	Rot. rev/min	Max table load		Height		Width × Depth		Weight	
		mm	in		Grad	Read to			kg	lb	mm	in	mm	in	kg	lb
H	O	254	10	M	30 sec	6 sec	—	—	181	400	127	5	387 × 330	15¼ × 13	41·5	91
H	O	305	12	M	30 sec	6 sec	—	—	181	400	141	5 9/16	419 × 330	16½ × 13	48	106
H/V	O	305	12	M	1 sec	—	—	—	181H 113V	400H 250V	152	6	406 × 406	16 × 16	91	200
H/V	O	406	16	M	1 sec	—	—	—	800H 300V	362H 136V	193	7⅝	559 × 508	20 × 20	158	350
H/V	O	610	24	M/P	1 sec	—	1/16	—	800H 300V	362H 136V	251	9⅞	622 × 622	24½ × 24½	261	575
H	O	762	30	P	1 sec	—	¼	4	1016	2240	248	9¾	1016 × 819	40 × 32	610	1344
H	O	914	36	P	1 sec	—	¼	4	1016	2240	248	9¾	1016 × 914	40 × 36	648	1428
H/V	D	406	16	M	1 sec	—	—	—	800H 300V	362H 136V	206	8⅛	533 × 483	20½ × 19½	209	460
H/V	D	610	24	M	1 sec	—	—	—	800H 300V	362H 136V	251	9⅞	610 × 610	24 × 24	261	575
H	D	762	30	P	1 sec	—	¼	4	909	2000	287	11½	1020 × 875	40 × 35	610	1344
I	O	203	8	M	2 sec (rotary)	30 sec (inclinable)	—	—	200H 100V	90H 45V	203	8	565 × 324	22¼ × 12¾	67	148
I	O	305	12	M	1 sec	—	—	—	400H 250V	181H 113V	206	8⅛	813 × 483	32 × 19	181	400
I	O	406	16	M	1 sec	—	—	—	800H 300V	362H 136V	235	9¼	1016 × 559	40 × 22	279	615
I	O	610	24	P**	1 sec	—	¼	1½	1500H 500V	686H 227V	533	21	1060 × 806	41¾ × 31¾	1010	2210
H	D	1067*	42*	P**	±0·001°***	±0·0003°****	¼	4	909	2000	375	15	1100 × 1075	44 × 43	611	1344

†H = Horizontal, V = Vertical, I = Inclinable
††O = Optical, D = Digital
†††M = Manual, P = Power-operated

*Also available with 762 and 914 mm (30 and 36 in) platen
**Automatic drive
***Automatic drive positioning accuracy
****Accuracy of repeatability

A member of The Newall Group
OPTICAL MEASURING TOOLS LIMITED
Water-Ma-Trout Road, Helston, Cornwall, England
Telephone: Helston 2366 Telex: 45295

OMT

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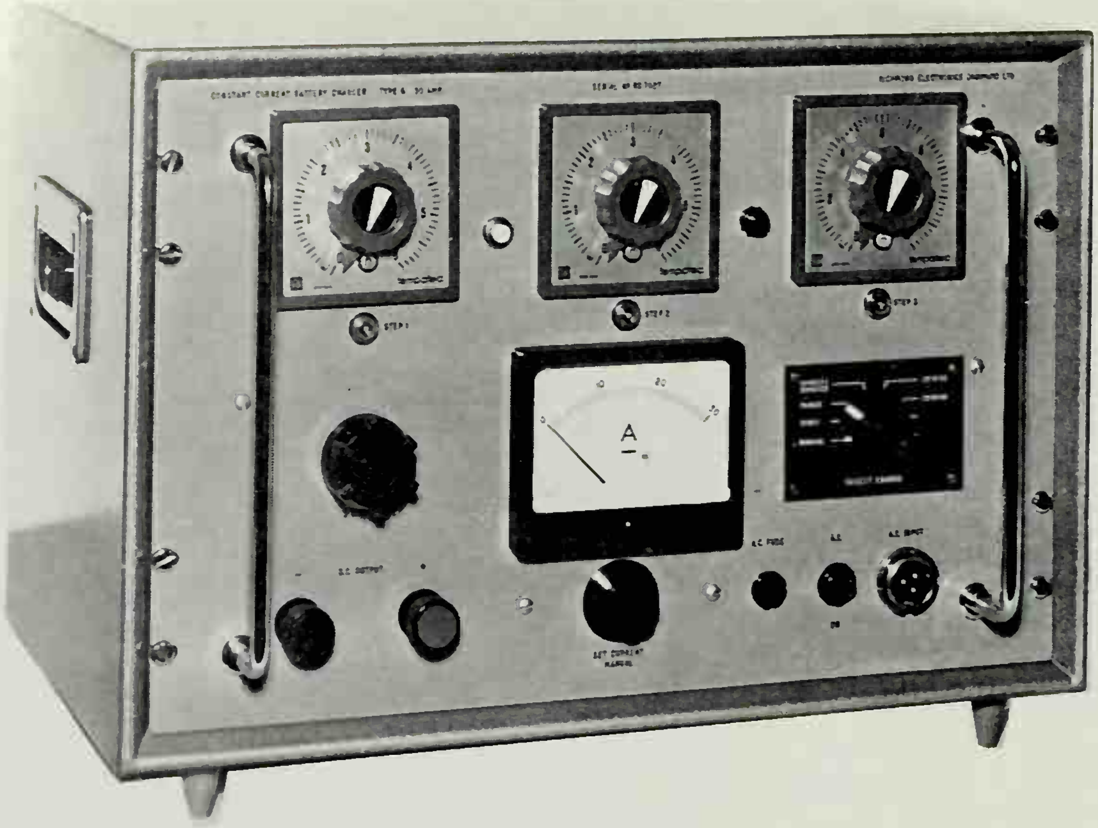
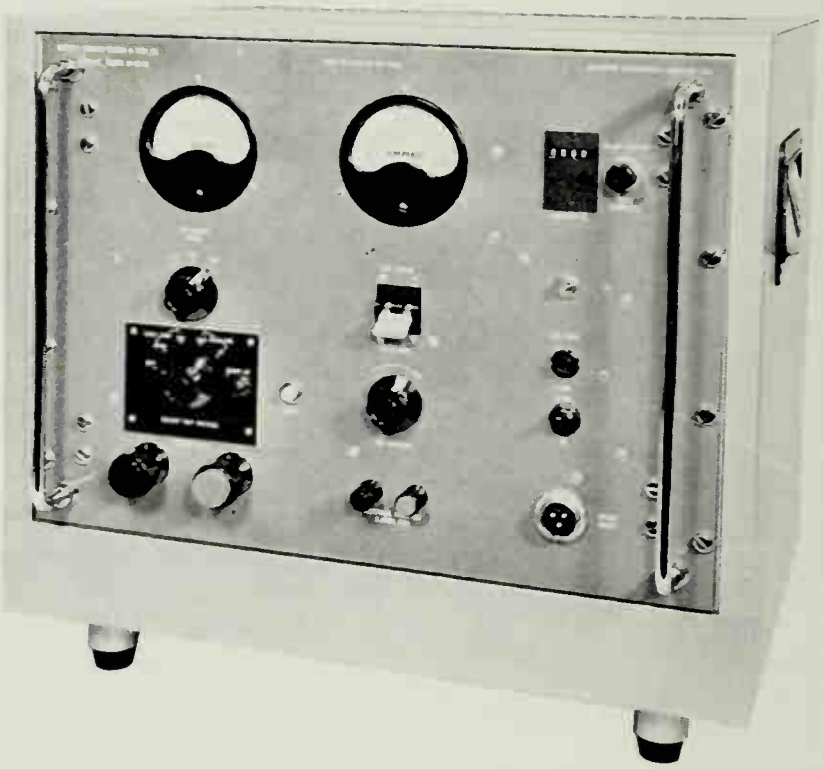
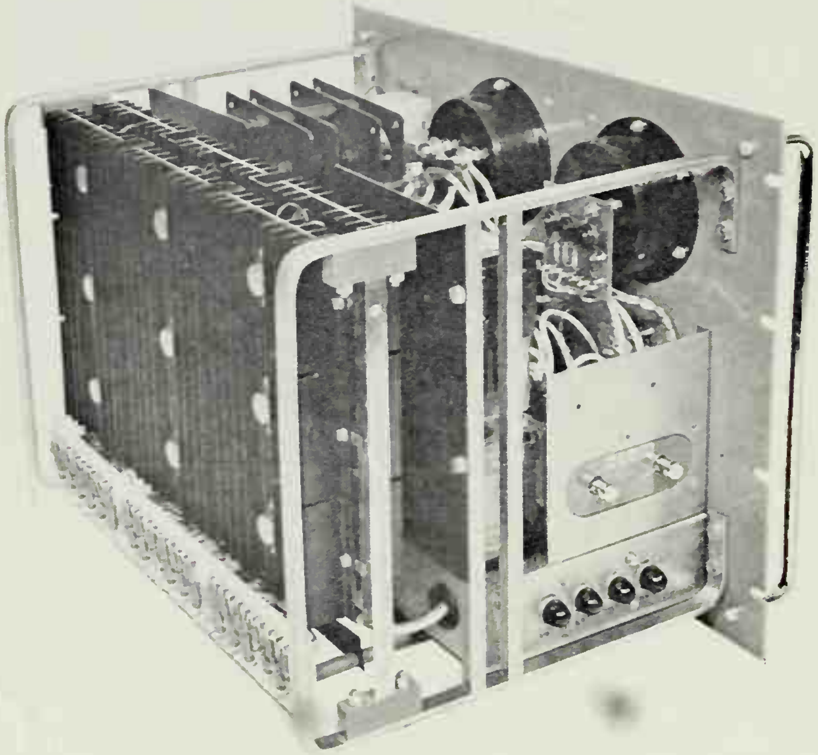


The Richmond Electronics Type 6 constant current battery charger is suitable for self-charging all types of batteries in three preset stages



The Richmond Electronics Type 2A battery capacity tester, suitable for batteries of any rated capacity. It discontinues discharge at any preset voltage level



View of the Type 2A battery capacity tester removed from case, showing the extremely robust construction and compact design based on the use of transistorised circuits

Battery equipment

for charging and testing storage batteries

No modern defence force could exist without storage batteries to provide electric power for a wide range of purposes. To ensure the longest possible life and efficient service from batteries of all types, Richmond Electronics has designed and developed a range of battery chargers and capacity testers which are in many respects unique.

Both the chargers and testers are of the universal kind, being suitable for both lead-acid and alkaline batteries. All units are fully transistorised and there are different models for fully automatic and manual operation.

Design of the units is standardised to render them suitable for mounting in standard 483 mm (19 inch racks), or for use as free-standing equipment.

Battery chargers

Many different models are available to suit every possible type of service. One of the most widely used is the constant-current battery charger Type 6 shown on the opposite page. It has a charging rate of up to 30 A.

The Type 6 charger is favoured where self-charging is essential. Operation is in three steps, each with its own presetting timer. The first and second step have a range from 0 to 6 hours, the third from 0 to 12 hours, so that a wide range of batteries can be catered for. The input may be 115 V 60Hz or 230 V 50 Hz, with the output variable from 0 to 36 V.

The unit measures 508 × 381 × 362 mm (20 × 15 × 14½ in) and its weight is 34 kg (75 lb).

Another widely used model is the universal constant-current battery charger Type RE 5A (NATO ref. No. 6130–99–222–6573), which was specially developed for military applications. Charging current may be set from 0·5 A to 20 A and remains constant throughout the charging period. Output voltage is from 3 V to 36 V, from a 115 V 60 Hz or 230 V 50 Hz mains supply input.

The circuit employs thyristor current control. Setting is by means of a knob on the front panel, the charging current being indicated on a standard 90 mm (3½ in) dial-type ammeter graduated to 25 A. Charging time is indicated by a four-digit electro-magnetic counter actuated by a synchronous clock unit; indication is in units of one-tenth minute.

The unit is available for standard 483 mm (19 in) rack-mounting or in a free-standing case. The dimensions of the case (including carrying handles) are 508 × 330 × 362 mm (20 × 13 × 14½ in).

This charger is particularly suitable for applications demanding a high degree of accuracy in charging current and ultimate battery performance.

Battery capacity testers

The battery capacity tester Type 2 is a universal fully transistorised unit designed to measure the capacity of all lead-acid and alkaline batteries ranging from 0 to 36 V with a discharge current from 0 to 50 A. The tester is suitable for use on batteries of rated capacities from one hour to ten hours.

Mains input may be 115 V 60 Hz single-phase or 230 V 50 Hz single-phase, consumption being 150 W max. The overall accuracy is better than 2 percent. Capacity is indicated by a four-digit counter directly in percent.

The Type 2 tester measures 534 × 482 × 432 mm (21 × 19⅛ × 17 in) including case and weighs about 32 kg (70 lb).

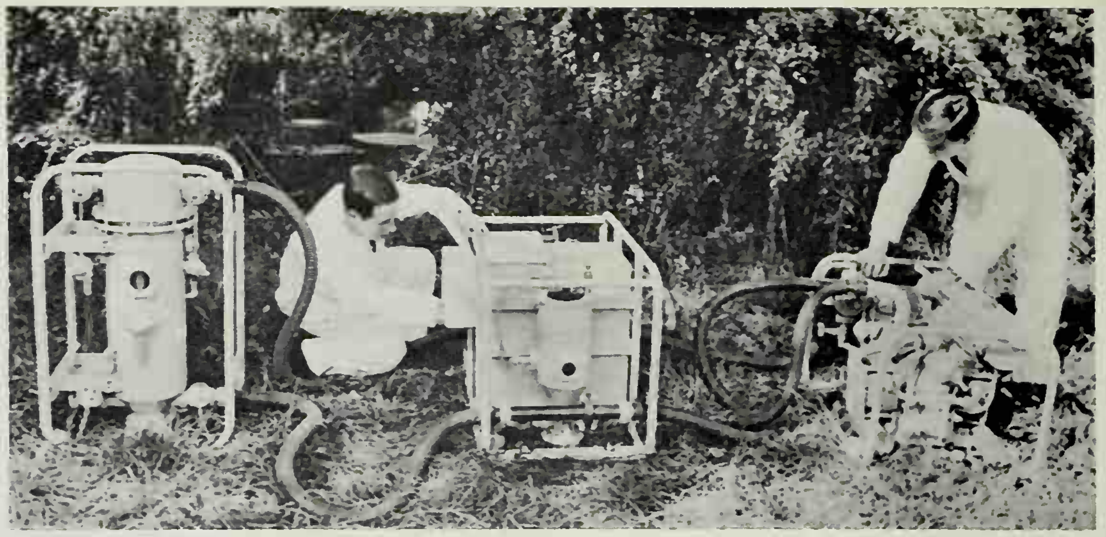
The Type 3 tester is similar to the Type 2, but to achieve a considerable reduction in size (65 percent) and weight (64 percent) some limitation in range had been accepted. The Type 2 measures only 508 × 254 × 305 mm (20 × 10 × 12 in) and weighs only about 11¼ kg (25 lb).

The test voltage range is from 0 to 30 V, discharge current from 10 A to 25 A. Mains power consumption is 100 W (115 V 60 Hz or 230 V 50 Hz). The accuracy of better than 2 percent has, however, been retained, as has the four-digit counter and the suitability for all types of battery.

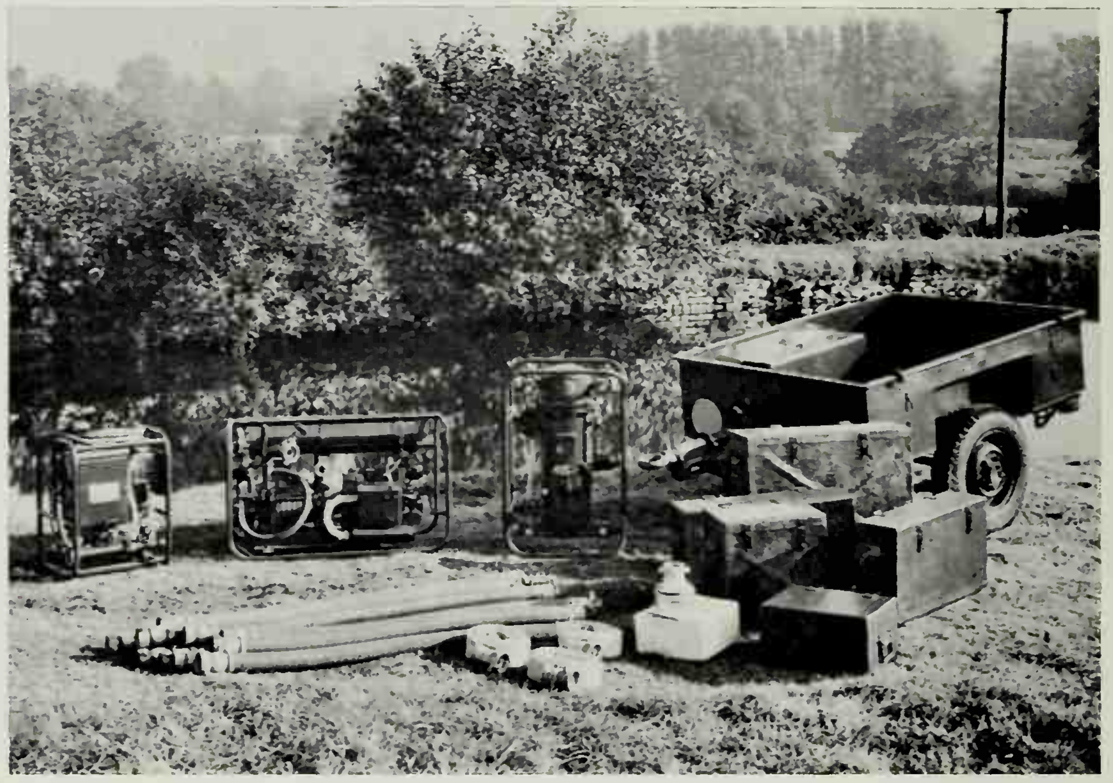
Other battery maintenance equipment is also available, as is a wide range of mechanical measuring and test equipment for use in workshops and in the field; some of these items are described elsewhere in this Catalogue.

RICHMOND ELECTRONICS (MARKYATE) LTD
Hicks Road, Markyate, St Albans, Hertfordshire, England
Telephone: Markyate 761

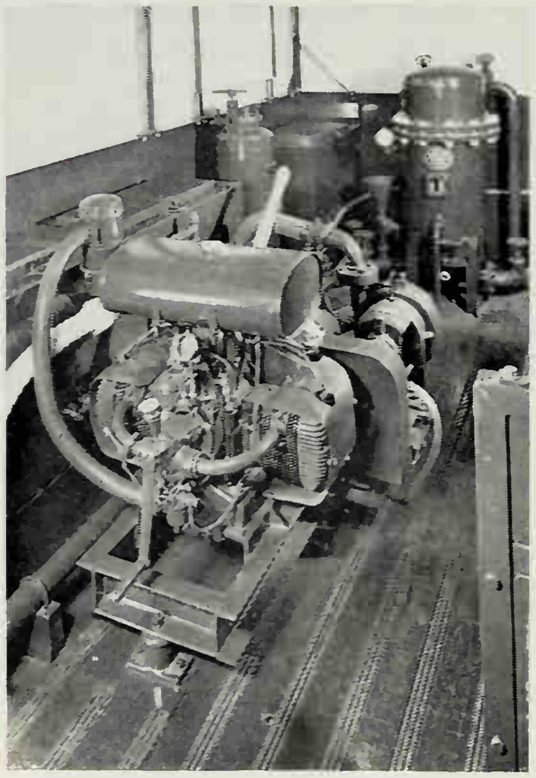
The Type AB2 set is a basic unit for supplying up to 4·5m³/h (160ft³/h) of sterilised filtered water. The equipment, complete with spares and accessories, is compact and readily transportable by a truck or similar vehicle



The Type AB3 set has been developed in conjunction with the British Ministry of Defence as a lightweight, air-portable equipment for military use with a capacity of up to 4·5m³/h (160ft³/h). Although similar to the AB2 it is built to a more exacting specification to allow the equipment to be dropped by parachute. The equipment, complete with stores and accessories, is contained within a 500kg (10cwt) two-wheeled trailer available as an optional extra



The Type 5B trailer-mounted unit is a completely self-contained plant capable of delivering up to 13·5m³/h (480ft³/h) of potable water. It is necessary merely to connect up the hoses for suction and delivery to make the equipment ready for use



The Type 6B trailer-mounted unit has been developed specifically to meet the requirements of the British Armed Forces. Also capable of delivering up to 13·5m³/h (480ft³/h) of potable water, it is mounted on a larger chassis than the Type 5B. A Stellar filter with a 75 percent increase in size over that used in Type 5B is utilised, providing longer filter cycles with reductions in running costs

Water purifiers

transportable and trailer-mounted equipment

One of the most essential supplies for any fighting force anywhere in the world is drinking water, yet it constitutes one of the most difficult logistic problems. The ability to produce potable water on the spot from sources which would otherwise be unfit for drinking is a tremendous advantage, especially to highly mobile self-contained fighting units.

The Stella-Meta range of water purification equipment has been specially designed for this purpose, with compactness and reliability as outstanding factors.

In addition to their military role, Stella-Meta water purifying units are ideal for the re-establishment of safe supplies of drinking water in emergencies such as earthquakes, fires and civil disturbances, in the course of which normal water supplies may be disrupted.

SPECIFICATIONS

Type AB2 transportable water purification equipment

Maximum rated capacity 4·5m^3/h (160ft^3/h)
Filter Stellar SW/7/AV, with filter area of 0·7m^2 (7·5ft^2)
Steriliser Clorocel SM/T/30 electrolytic sterilising unit

Dimensions
Filter unit 940 × 610 × 470mm (37 × 24 × 18½in)
Steriliser/Filtraider unit 965 × 560 × 660mm (38 × 22 × 26in)
Engine/pump/generator unit 965 × 560 × 610mm (38 × 22 × 24in)

Weights
Filter unit 72kg (159lb)
Steriliser/Filtraider unit 82kg (181lb)
Engine/pump/generator unit 119kg (262lb)

The Type AB2 equipment is supplied complete with interconnecting hose, spares, accessories and tools

Type 5B trailer-mounted water purification equipment

Maximum rated capacity 13·5m^3/h (480ft^3/h)
Filter Stellar SW/20/AV, with filter area of 2m^2 (21·5ft^2)
Steriliser Clorocel SM/T/60 electrolytic sterilising unit

The complete Type 5B water purification equipment, including engine and generator, is mounted in a four-wheeled trailer fitted with lockers, storage bins, and canvas top and side screens. The unit is supplied complete with spares, accessories and tools

Dimensions
Trailer, ready for towing, 4570 × 1940 × 2540mm (15ft × 6ft 4½in × 8ft 4in)

Type AB3 air-portable water purification equipment

Maximum rated capacity 4·5m^3/h (160ft^3/h)
Filter Stellar SW/7/AV, with filter area of 0·7m^2 (7·5ft^2)
Steriliser Clorocel SM/T/30 electrolytic sterilising unit

Dimensions
Filter unit 940 × 610 × 470mm (37 × 24 × 18½in)
Steriliser/Filtraider unit 520 × 470 × 660mm (20½ × 18½ × 26in)
Engine/pump/generator unit 1065 × 635 × 660mm (42 × 25 × 26in)

Weights
Filter unit 81kg (178lb)
Steriliser/Filtraider unit 64kg (141lb)
Engine/pump/generator unit 146kg (322lb)

Trailer (supplied as extra)
Type modified GS two-wheeled trailer with all-metal body
Trailer weight, empty 370kg (816lb)
Total weight, equipment stowed 865kg (1907lb)
Overall size of trailer, equipment stowed 2750 × 1360 × 1280mm (9ft × 4ft 6in × 4ft 2½in)

The Type AB3 equipment is supplied complete with interconnecting hose, spares, accessories, tools and resin-bonded glass fibre storage cases. The equipment is comprehensively catalogued to the NATO system of codification

Type 6B trailer-mounted water purification equipment

Maximum rated capacity 13·5m^3/h (480ft^3/h)
Filter Stellar SW/35/AV, with filter area of 3m^2 (32ft^2)
Steriliser Clorocel SM/T/60 electrolytic sterilising unit

The complete Type 6B water purification equipment, together with engine and generator, is mounted on a 2-ton four-wheeled trailer fitted with lockers, storage bins, and canvas top and side screens. It is supplied complete with spares, accessories and tools. This equipment has been extensively catalogued to the NATO system of codification

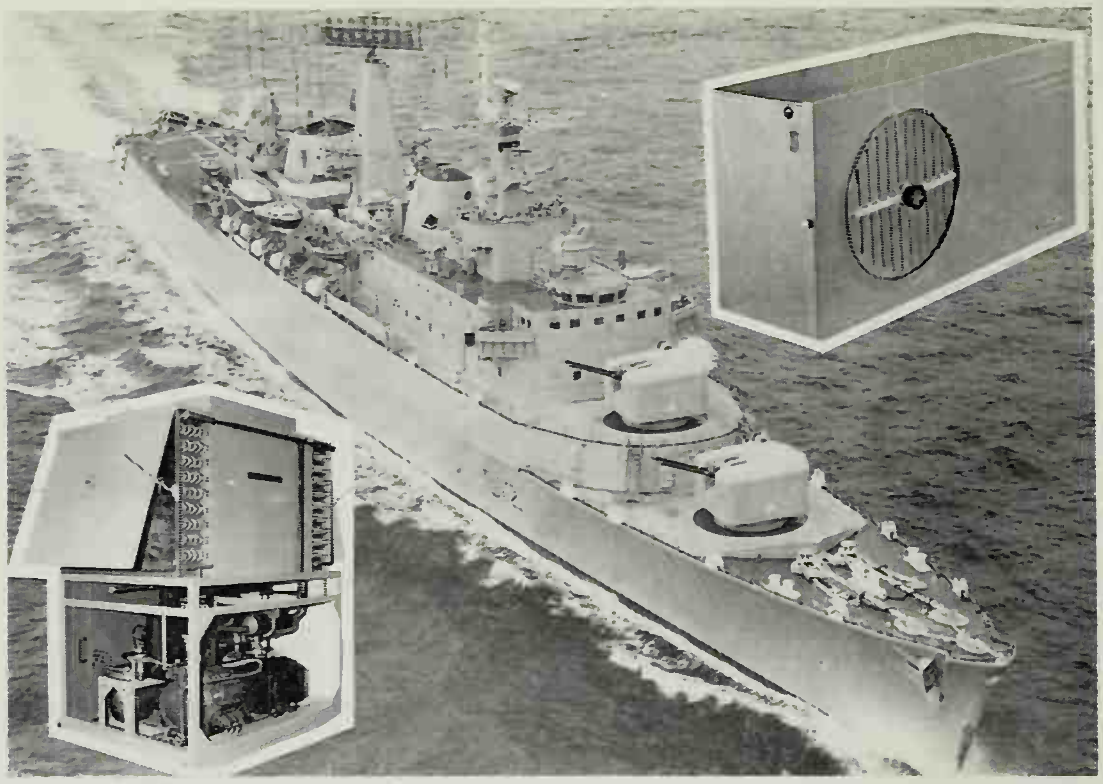
Dimensions
Trailer, ready for towing, 7070 × 2410 × 2780mm (23ft 2⅜in × 7ft 11in × 9ft 1½in)

STELLA-META FILTERS LIMITED
Laverstoke Mill, Whitchurch, Hampshire, England
Telephone: Whitchurch (Hants) 2360   Cables: Stellameta Whitchurch Hants   Telex: 85145

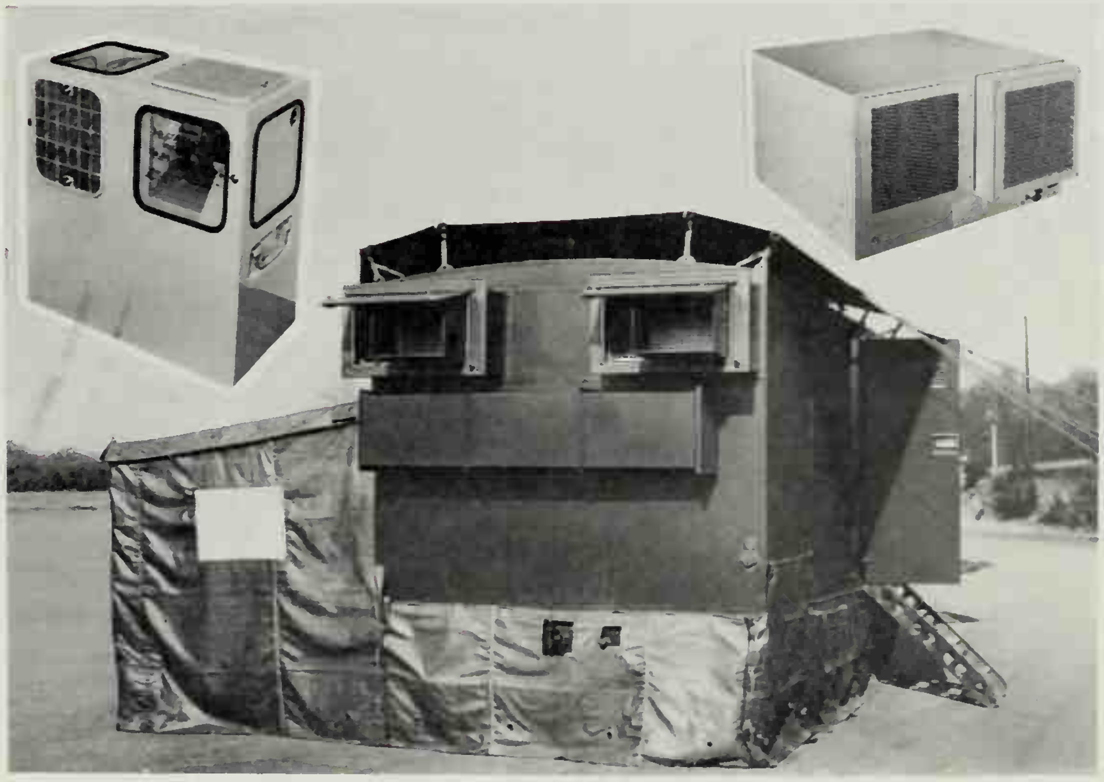
Today the various branches of the armed forces possess some of the most sophisticated equipment available to man. To maintain this equipment at its highest efficiency and the crew at their desired mental alertness, air conditioning and environmental control are now considered to be essential.

Temperature Limited has designed, developed and manufactured environmental control equipment for the British Armed Forces for the past 20 years. This equipment is also used by a number of other governments, including those of Sweden, South Africa, Australia, India, Pakistan and New Zealand.

Temperature Limited's range of conditioners and conditioning plant spans all branches of the armed forces.



Crown Copyright



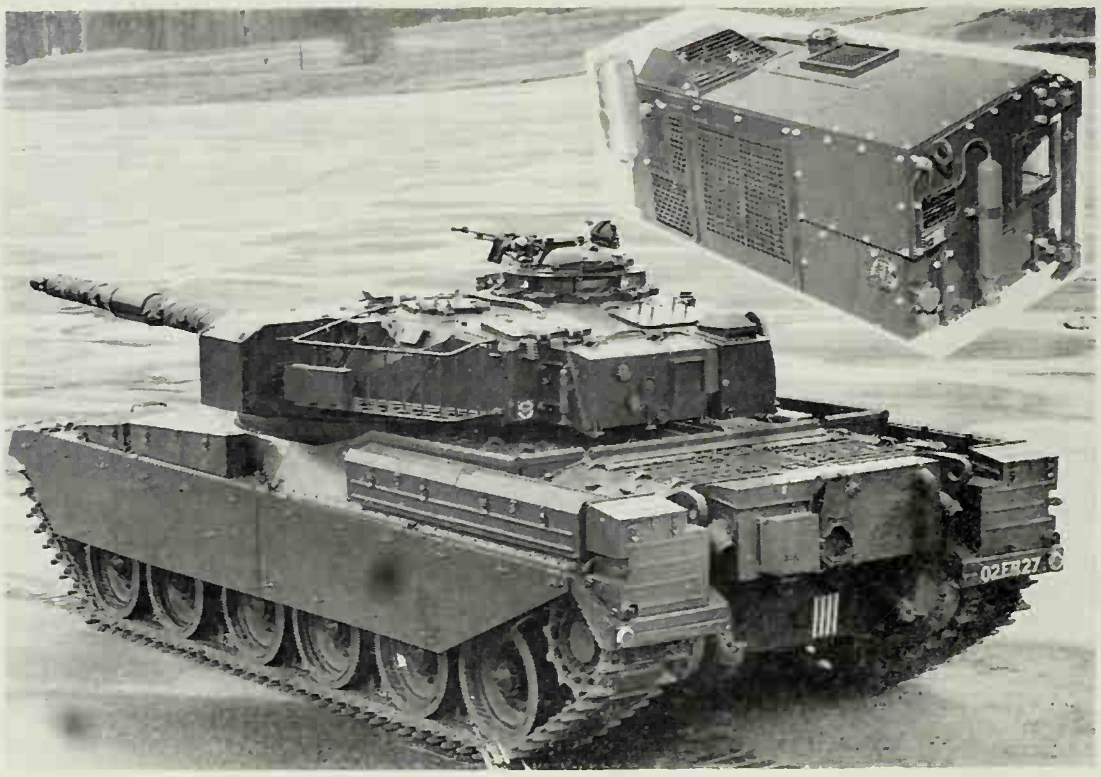
Naval units include the sea-water cooled APW series of air conditioners for cabins and control rooms, and larger special plant for ammunition lockers, electronic equipment and dockyard installations.

Temperature Limited has developed and manufactured a range of vehicle air conditioners and coolers, easily adaptable for many applications, especially technical vehicles, simulators, photo processing vehicles, radar systems, and mobile workshops.

This range of air conditioners and coolers has been extensively used in the Bloodhound and Thunderbird defence systems and in mobile satellite tracking stations.

Development
In addition to the above conditioners, Temperature Limited has carried out considerable development work on the environmental control of tracked vehicles, to meet the rigorous specifications demanded for the extremes of tropical and sub-zero conditions.

Buildings
Temperature Limited plant has been used in connection with a number of defence projects: for the air conditioning of living accommodation, working and recreational areas in Saudi Arabia; the conditioning of an ordnance factory in Pakistan; and underground tracking stations for the United States services in the UK.

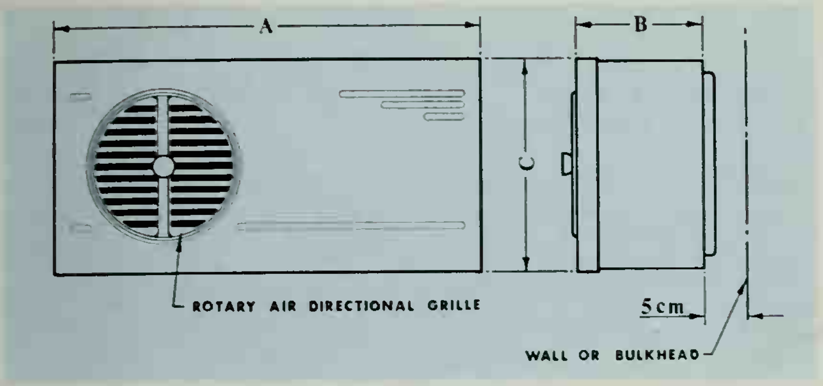


Environmental control

air conditioning to Ministry of Defence standards

APW air conditioners for naval vessels

A range of units for cabin, store room and control room use has been designed with sea-water cooled condensers. These compact units incorporate a hermetically sealed refrigeration system, filters and air direction grilles. Installation kit and fixing brackets are provided.

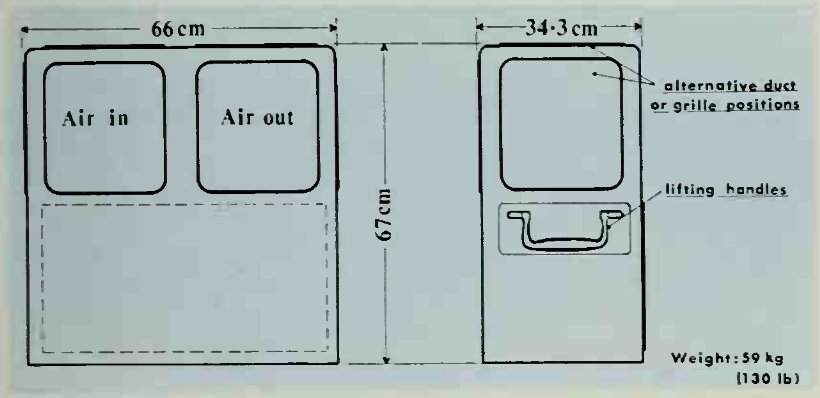


SPECIFICATION

MODEL NUMBER	ELECTRICAL SUPPLY	COOLING DUTY *		CONDENSER WATER FLOW RATE		AIR FLOW		DIMENSIONS cm		
		btu/h	frigories/h	gal/min	litres/min	ft^3/min	m^3/h	A	B	C
APW 7	200/220V 1phase 50 Hz	7000	1760	1	4·54	220	375	68·6	20·95	34·3
APW 9	440V 3phase 60 Hz	9000	2260	1	4·54	340	580	71·12	27·3	35·6
APW 12	440V 3phase 60 Hz	12000	3030	1	4·54	380	645	71·12	27·3	35·6
APW 24	440V 3phase 60 Hz	20000	5050	2	9·08	520	885	76·2	54·6	45·7
TEST CONDITIONS *	AIR ON TO EVAPORATOR 26·6°C(80°F)D.B. 19·4°C(67°F) W.B. CONDENSER WATER INLET TEMPERATURE 23·5°C(75°F)									

Vehicle air conditioning

Lightweight air conditioners and liquid coolers are specially designed for pressurised vehicle and sterile air filtration systems, using alloy components and a hermetically sealed refrigeration system. The units are suitable for use in static applications or in military vehicles. Special fixing means for vehicle use are provided.

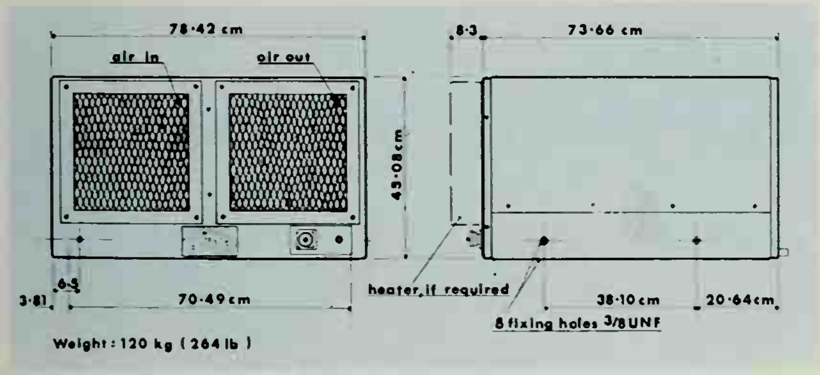


SPECIFICATION

SELECTION OF ELECTRICAL SUPPLIES		208V 3 phase 400 Hz 220/240V 1 phase 50 Hz 380/440V 3 phase 50/60 Hz
COOLING DUTY	Test condition	49°C (120°F) D.B. 29·4°C (85°F) W.B. outside 26·6°C (80°F) D.B. 19·4°C (67°F) W.B. inside 2268 frigories/h (9000 btu/h)
	Heating: if required	2520 kcal/h (10 000 btu/h)
	Indoor fan	595 m^3/h (350 ft^3/min)
LIQUID COOLING DUTY	Test condition 'A'	49°C (120°F) D.B. outside 2268 frigories/h (9 000 btu/h)
	Test condition 'B'	35°C (95°F) D.B. outside 2646 frigories/h (10 500 btu/h)
	Liquid flow	11·4 litres/min (2·5 gal/min)

Multi-purpose air-cooled air conditioner

The AC52 unit provides control in almost any environment. It can be used with various controls and is easily adapted using standard kits to provide heating, dehumidification, filtration, ducting, etc., to suit applications ranging from vehicles to computer rooms. The unit also has a hermetically sealed refrigeration system, stainless steel mesh air filters, and fresh air control.
This packaged unit is also available for liquid cooling.



SPECIFICATION

SELECTION OF ELECTRICAL SUPPLIES		208V 3 phase 400 Hz 220/240V 1 phase 50 Hz 380/440V 3 phase 50/60 Hz
COOLING DUTY	Test condition	49°C (120°F) D.B. 29·4°C (85°F) W.B. outside 29·4°C (85°F) D.B. 22·8°C (73°F) W.B. inside 2520 frigories/h (10 000 btu/h)
	Heating: if required	1720 kcal/h (6826 btu/h)
	Indoor fan	680 m^3/h (400 ft^3/min)
LIQUID COOLING DUTY	Test condition	49°C (120°F) D.B. 29·4°C (85°F) W.B. outside 2520 frigories/h (10 000 btu/h)
	Liquid flow	11·4 litres/min (2·5 gal/min)

Temperature Limited undertakes development work for the Ministry of Defence in all fields of environmental control, and manufactures to MOD specification shipboard air conditioners and coolers, vehicle air conditioning and multi-fuel heating equipment, pressurised vehicle and sterile air filtration systems, general-purpose conditioners and coolers to MOD standards, drinking water coolers, as well as central plant and room conditioners for all types of buildings.

A member of the Norcros Group
TEMPERATURE LIMITED
192-206 York Road, London SW11, England
Telephone: 01-223 0511 Cables: Tetmur London SW11 Telex: 28228

Nylon nets and netting

for camouflage, cargo movement and restraint

Bridport-Gundry Ltd has been a contractor to British Governments for over 200 years, specialising in the supply of nets and cordage. Man-made fibres have enabled us to design and engineer a range of nets to meet the needs of this technical age, and to function efficiently in a variety of defence roles. Nylon, in the highest tenacities available, is processed into cords for surgical sutures, parachute cords and into nets for lifting and restraining cargo, as well as for camouflaging vehicles and defence positions.

Materials: all synthetic fibres, but primarily Nylon 66 high tenacity, bright, for maximum strength and energy absorption and for least weight.
Specifications: own, British Government or British Standards Institution.
Approvals held: AQD (formerly AID) of British Ministry of Technology, Ministry of Defence, Admiralty, Air Registration Board, General Post Office, and British Standards Institition.

Cargo nets
1500 kg helicopter cargo net to Drawing JG 562 Issue 9, octagonal, 380 cm (12 ft) dia. Mesh size: 15 cm. Weight: 10 kg. To lift 1500 kg. Safety factors: nylon net 6:1, steel hook-up 4:1. Fitted rapid hook-up mechanism, and abrasive resistant coating on net. In service use in all climates for four years.

5000 kg net is also available, to Drawing BG N 745, 600 cm (20 ft) dia. Weight: 45 kg. General specification similar to the above.

Restraint nets
Restraint net for palletised cargo to Drawing BG N 711, a one-piece net. Mesh size: 10 cm. Weight: 34 kg. To restrain up to 4536 kg (10 000 lb) to 4 g, loose cargo on international pallets size 224 × 274 cm (88 × 108 in) × up to 250 cm high, in cargo-carrying and supply-dropping aircraft. 36 rapid adjustable tensioning straps fit pallet lashing positions; a water-proof cover is incorporated under net. In service with the Royal Air Force. Similar nets have been in use with international airlines for ten years.

Restraint net Mk 2 JG N 559 and canvas cover JG N 560. Nylon net wrap-around type, size 900 × 133 cm. Mesh size: 6 cm. Weight: 10 kg. Canvas cover 230 × 265 cm. To restrain loads of 3500 kg for freighting and parachuted supplies dropping.

500 kg loose cargo restraint net to Drawing JG N 643 Issue E, rectangular, nylon size 200 × 265 cm. Mesh size: 12 cm. Weight: 4 kg. To secure loads of mixed cargo, baggage or spares on aircraft floor or cabin, or helicopter cabin, restrains 500 kg to 5 g. 23 snap-hook fittings of 1000 kg ultimate strength each are fitted at positions to engage floor attachments; two or four nets can be linked together to cover larger areas.

Camouflage nets
These are made of nylon fibre developed by us especially for the British Ministry of Defence. Some hemp fibre is used for some specifications. Plain nets or nets completely garnished to vegetation, sand and snow colours. Specifications to British Ministry of Defence Nos UK/ISC/S/3115A–3592 inclusive. Sizes: from 4·25 × 2·13 m for personnel to 12·3 × 12·3 m for vehicles and aircraft. Mesh sizes: 5, 7·5 or 10 cm. Leaf-garnished coverage from 62–100 per cent.

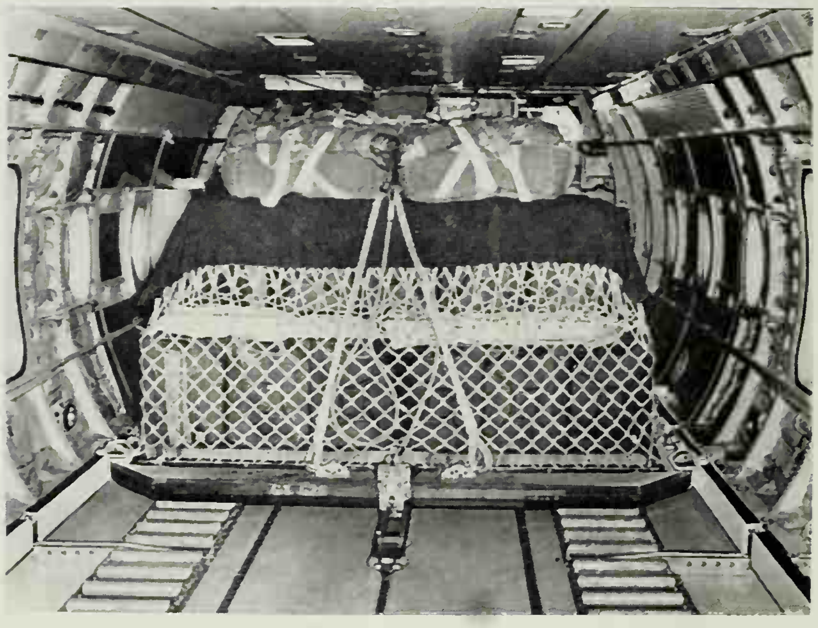
We also make helmet camouflage nets to current specifications and to fit all helmets.

Safety nets
We make safety nets to British Standard Specification 3913, of nylon cord of 550 kg breaking load, mesh size 10 cm, to any specified dimensions.

Cordage
A wide variety of cordage, plaited and cabled, is manufactured from nylon, polyester, polythene, polypropylene and natural fibres to British Standards Specifications and all UK and many world defence specifications. Lanyards and rifle pullthrough cords are also made.

A mixed palletised load being winched from a helicopter in a typical Bridport-Gundry helicopter cargo net

Forward command post camouflaged by several Bridport-Gundry camouflage nets



Supplies palletised for air-drop secured by Bridport-Gundry restraint net, seen here in aircraft hold

BRIDPORT-GUNDRY LIMITED
Industrial Division
Bridport, Dorset, England
Telephone: Bridport 2244 Cables: Netting Bridport Telex: 41132

Mechanical seals

for all types of rotating shaft equipment

Flexibox mechanical seals are designed positively to prevent leakage from centrifugal and rotary pumps, agitators and mixers, compressors and vacuum pumps and many other types of rotating shaft equipment. They are used in oil refineries, chemical works, food factories, power stations, aeroplanes, motor cars and by defence forces. Wherever there is a rotating shaft there is an application for a Flexibox mechanical seal.

The range of Flexibox mechanical seals is extremely wide, covering a great variety of applications. Some of the more standard types are listed below.

RM (metric size)
RA (inch size)

The basis unbalanced seal for pressures up to 10·5 kgf/cm^2 (150 lbf/in^2) gauge

RR

The basic Flexibox balanced seal for pressures up to 8·4 kgf/cm^2 (120 lbf/in^2) gauge

Chemiflex

Flexibox mechanical seal for highly corrosive conditions

FF-S

The Flexibox seal for high operational speeds or highly viscous products

RR-SM

A multi-spring seal for very severe duties

RFM (metric sizes)
RFA (inch sizes)

Double-seals for use below 10·5 kgf/cm^2 (150 lbf/in^2) gauge

RRF and RRFF

Double-seals for use above 10·5 kgf/cm^2 (150 lbf/in^2) gauge

RRYB

A vapour-phase seal for light hydrocarbons

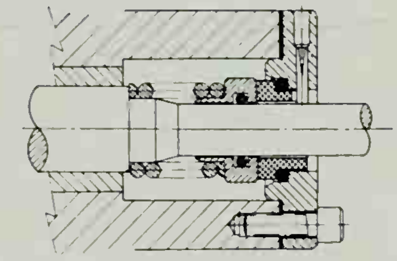
RRV-ST

A seal for dealing with high temperatures without the use of auxiliary services

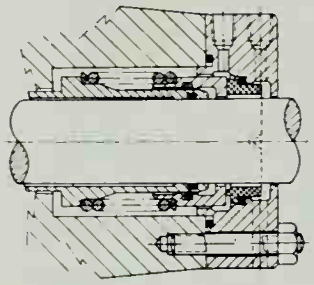
RM-D (metric size)
RA-D (inch size)

Dual-rotation seals

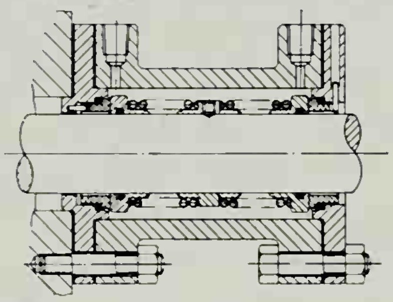
Unbalanced seals



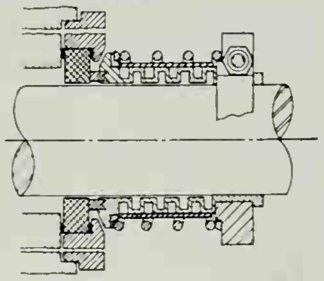
Balanced seals



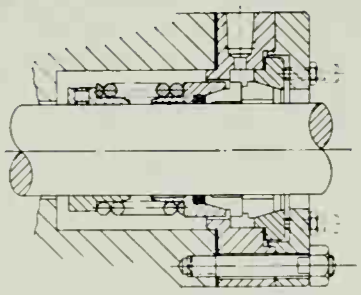
Double seals

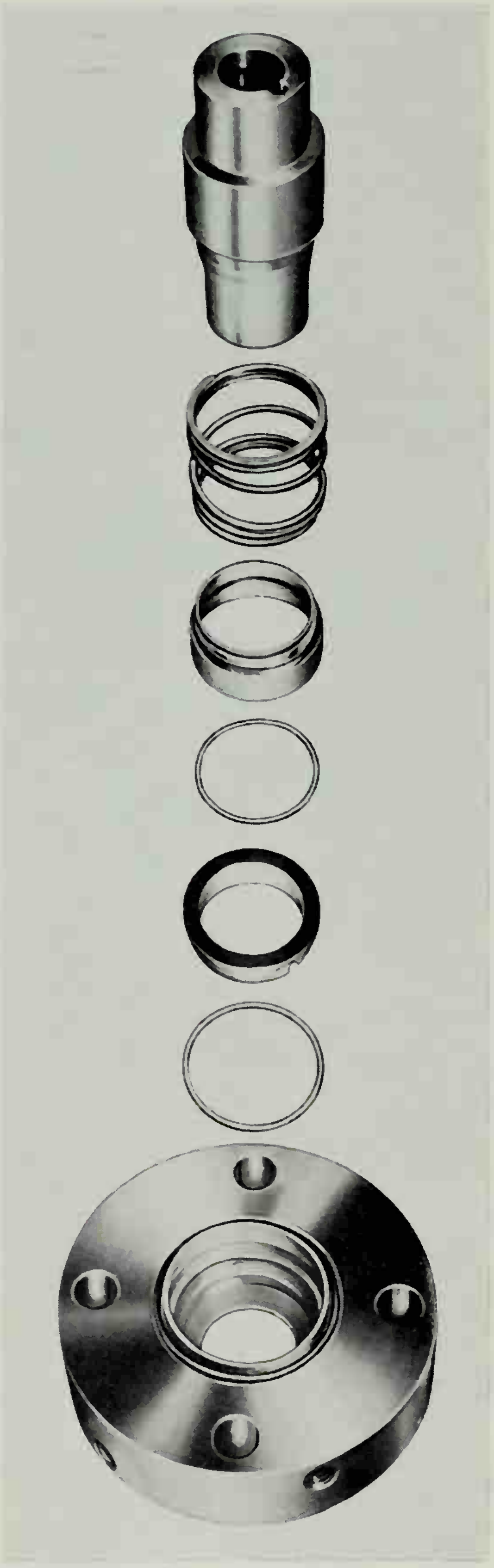


Chemiflex seals



Sectaflex seals





Operating limits

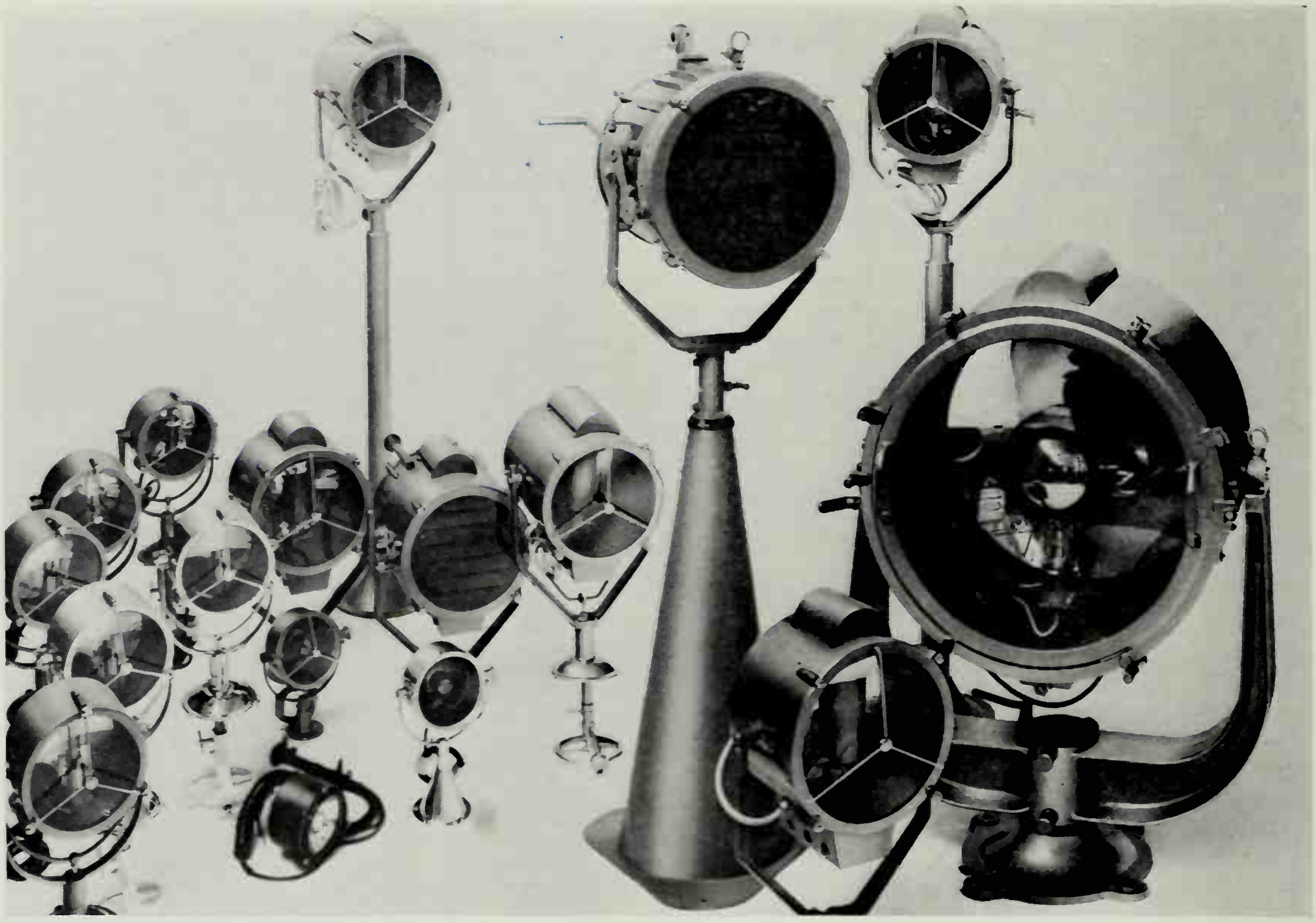
The operating limits of mechanical seals are determined largely by the absence or presence of optional design features or by the use of auxiliary equipment. Full details of the operating limits of Flexibox mechanical seals are given in the publications dealing with particular seals

FLEXIBOX LIMITED
Nash Road, Trafford Park, Manchester, M17 1SS, England
Telephone: 061-872 1477 Telex: 66284

flexibox

Searchlights

for all purposes



Above: Some of the many types of searchlights and signalling units made by Francis. Type of mounting and controls can be readily adapted to suit individual requirements

Left: A small selection of warning lights, horns and bells made by Francis for military, para-military and civil services

Francis manufactures a full range of searchlights for all voltages and duties, as well as day and night signalling projectors and hand lanterns. A representative selection of these products is shown in the two illustrations, and many other products are made to meet special requirements.

Standard searchlight specifications cover the following ranges:

Diameters:	178 mm (7 in) to 710 mm (28 in)
Voltage:	6, 12, 24, 32, 80, 110 and 220 V
Wattage:	48 W to 2 kW
Range:	420 m (460 yd) to 2600 m (2840 yd). Special light sources with greater range are also available.

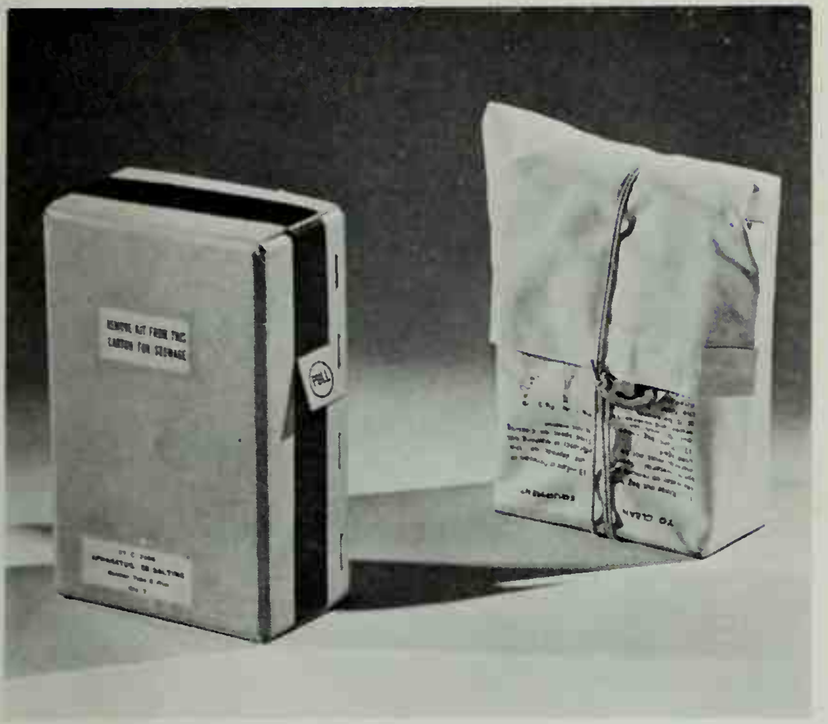
In addition to searchlights and signalling lamps, Francis also manufactures a range of specialised electrical equipment, including bells (electrical and manual systems), syrens, alternating horns, flashing beacons, vehicle-mounted searchlights (interrupter unit for flashing warning), cable reels and tripods, floodlights (both for pendant and vertical mounting), air horns to British Home Office specifications, lightweight rotating beacons with magnetic base for portable use and instant attachment to staff cars, and many similar products.

Francis equipment is in continual use in many parts of the world and enjoys a good reputation for high standards of design and engineering.

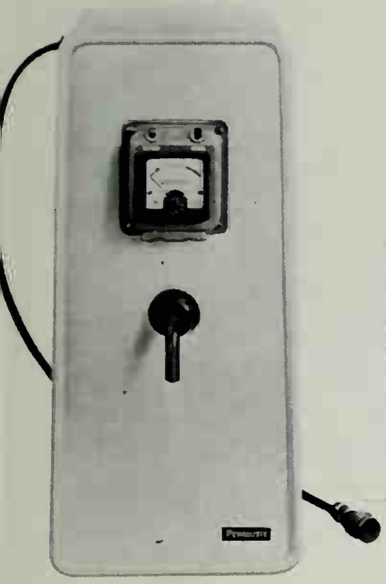
FRANCIS SEARCHLIGHTS LIMITED
Turner Bridge, Bolton, Lancashire, England
Telephone: Bolton 27196 Cables: Francis Bolton

Water purifying units

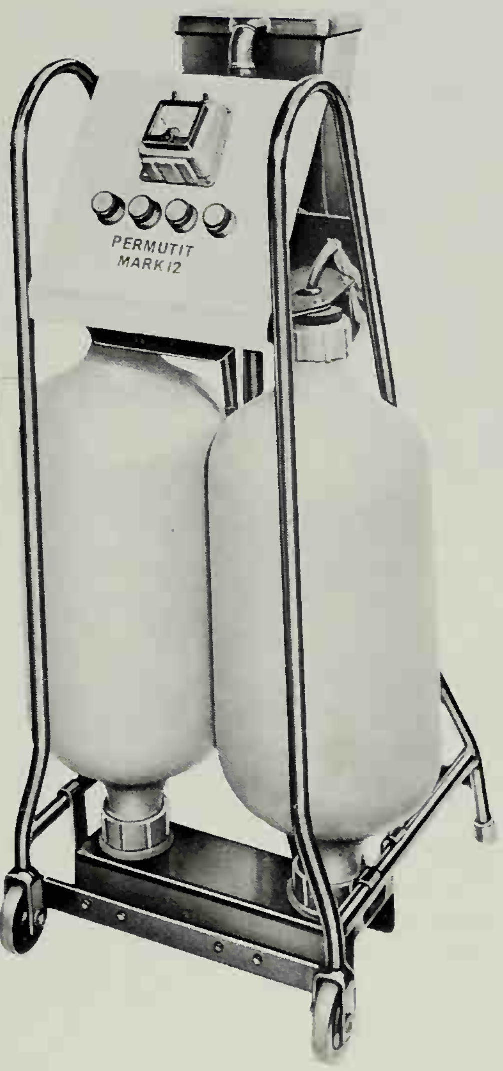
for desalination and de-ionisation



Seawater desalting kit



Mk 17 de-ioniser



Mk 12 de-ioniser

Permutit seawater desalting kits

Permutit desalting kits convert small quantities of seawater into water suitable for drinking: they have proved invaluable in contributing to survival at sea.

They are approved by the British Aeronautical Inspectional Directorate and are standard items of equipment for the Royal Air Force under the following RAF vocabulary reference:

Apparatus, desalting, 2-pint, reference 27C/2467
Apparatus, desalting, 6-pint, reference 27C/2398

They are also approved as standard equipment to be carried in marine lifeboats and rafts under the international Convention for the Safety of Life at Sea, 1960.

These kits are supplied in two sizes for producing 1·14 litres (2 pints), and 3·4 litres (6 pints) of drinking water respectively.

Specification

1 cardboard container with pull-off adhesive tape
1 storage bag of flexible rubberised fabric, with securing cord
1 purifier bag of flexible rubberised fabric, with integral filter pad, drinking tube, plug and lanyard
3 chemical charges (2-pint kit), or
10 chemical charges (6-pint kit)

Each chemical charge comprises 4 cubes double-wrapped in heat-sealed Cellophane. One chemical charge produces the following quantities of drinking water from seawater having a salinity of 35·5 grammes per 1000 grammes (standard seawater on which performance of kit is based):

Treated water quality (parts per 100 000):

Chlorides as $NaCl$	255
Sulphates as Na_2SO_4	255
Phenolphthalein alkali as $CaCO_3$	20
Methyl orange alkali as $CaCO_3$	40
Total dissolved solids	550

Permutit portable de-ionisers

De-ionised (demineralised) water of exceptionally high quality is produced from the Permutit Mk 8 portable de-ioniser simply by attaching the hose connection of the unit to any nearby raw water tap. Treated water is then immediately available at tap speed. Flow rate up to 180 litres (40 gal) per hour.

There are no installation costs, and no heat or power is required. The unit is completely portable and can be wheeled from site to site.

These units are regenerated by the user simply and quickly using hydrochloric acid and caustic soda. Hundreds of gallons of treated water are obtained from each regeneration at a negligible cost.

Permutit de-ionisers are widely used by all services. Typical applications include demineralised water for aircraft assisted take-off, topping up all types of batteries, photographic work, pharmaceutical and laboratory requirements. They completely outdate the use of distilled water purchased in bulk form.

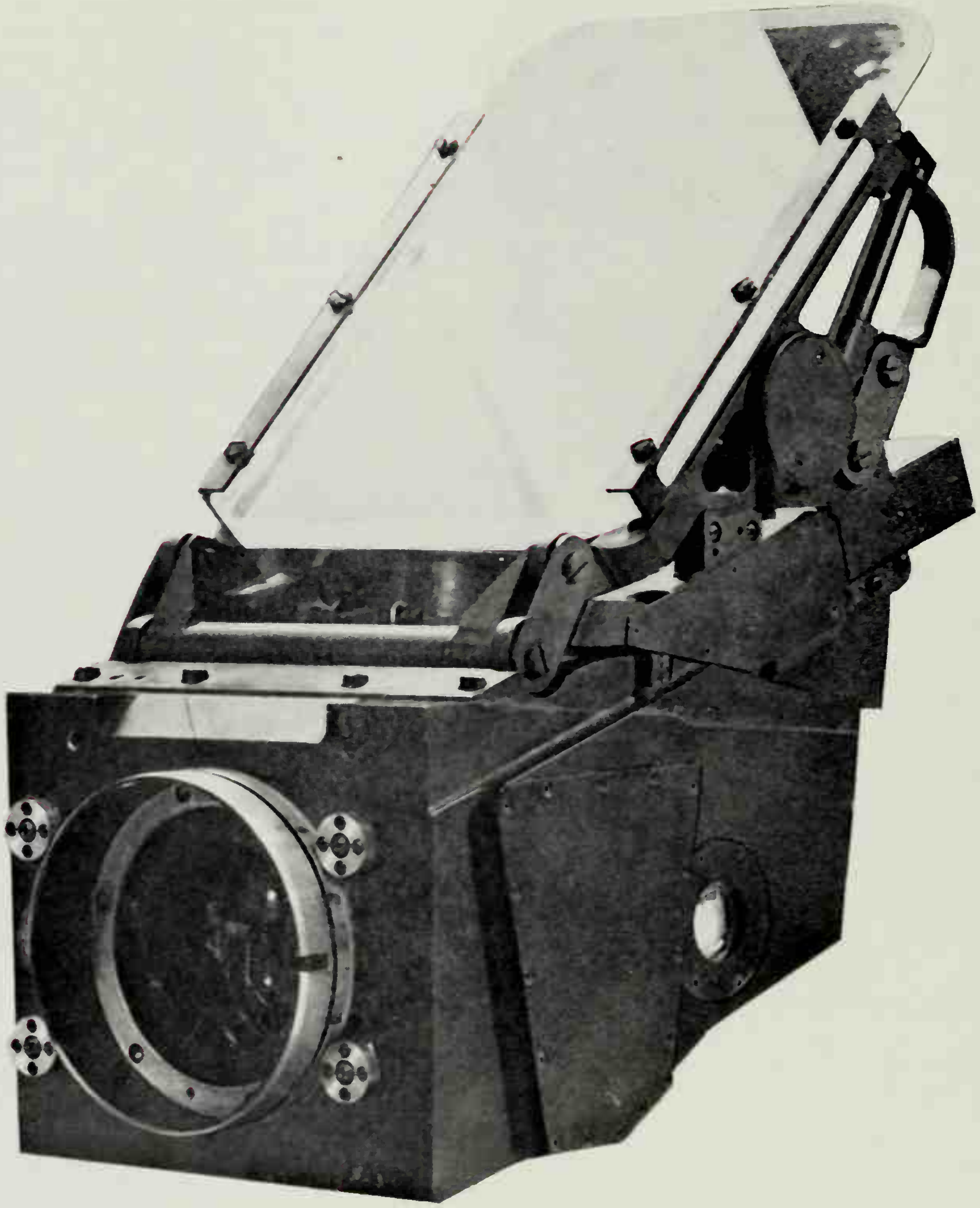
The Mk 17 unit is a cartridge-type portable de-ioniser and operates in a manner similar to that of the Mk 12, except that when the ion-exchange resin contained in the cartridge is exhausted (as indicated by the conductivity meter) the resin is thrown away and replaced with a charge of fresh resin supplied with the unit. It is a small, inexpensive and compact unit which can be hung on a wall or placed on a bench, is portable, lightweight, foolproof, and has a flow rate of up to 108 litres (26 gal) per hour of ultra-pure water.

THE PERMUTIT COMPANY LIMITED
Pemberton House, 632–652 London Road,
Isleworth, Middlesex, England
Telephone: 01-560 5199 Cables: Permutit Hounslow Telex: 24440

PERMUTIT

Optical systems

for defence purposes



Optical module for head-up display system

Pilkington Perkin-Elmer Ltd offers a service to industry and governments in the field of optical design and in the development and production of optical systems.

All work is carried out by specialists experienced in military and aerospace equipment and its applications.

Typical products

- Airborne map-reader optics
- Infra-red lens systems
- Colour-separation optics for TV cameras
- Lens system for electrostatic copiers
- Low-light TV and night-viewing optics
- Wide-angle TV lenses
- Aircraft flight-simulation optics
- Missile-tracking systems

PILKINGTON OPTICAL DIVISION

PILKINGTON PERKIN-ELMER LIMITED
Glascoed Road, St Asaph, Flintshire, Wales
Telephone: St Asaph 3301 Cables: Optical St Asaph Telex: 61291

Self-luminous products: compounds, nuclear lamps, signs and markers

Brandhurst, specialists in self-luminous products and materials, offers a comprehensive service in this field, including the development and design of self-luminous light sources (tritium gas-activated nuclear lamps).

We make a complete range of nuclear lamps to DEF Standard 62-4, also proprietary products marketed as 'Permluco' microlights. These self-powered lamps, used extensively for instrument dial illumination, can be incorporated into new or existing equipment. They are also available in the form of signs and markers for aircraft and vehicles.

Other products include self-luminous paint compounds complying with MOD and DTD specifications Component luminising and complete dial fabrication to specific requirements are also undertaken.

Brandhurst Co Ltd
Wellington Road, High Wycombe, Buckinghamshire, England
Telephone: High Wycombe 25106

Cryogenic coolers for infra-red devices

A comprehensive range of Minicooler (miniature Joule Thomson cryogenic liquefier) systems for cooling infra-red detectors in military equipment such as airborne linescan, ground surveillance, FLIR, missile guidance and fuzing.

Rapid cooling, fixed orifice and self-regulating Minicoolers are in service cooling IR detectors to between −40°C (233°K) and −253°C (20°K); sizes meet most international standards of detector cells Operational systems can be built from approved elements or integrated into a system custom-built for each application. Short duration, single or multiple start or long-duration systems for logistic support equipment, man-portable, transportable or permanently installed units are available.

The Hymatic Engineering Co Ltd
Glover Street, Redditch, Worcestershire, England
Telephone: Redditch 63621
Cables: Hymatic Redditch
Telex: 33634

Security and protective film laminating equipment for identification cards and printed matter

Our laminating systems use tough plastic films and simple machines to protect printed matter.

Heavy-gauge Morane film seals identification cards to produce a durable, tamper-proof record of personal data, photograph, signature, fingerprint, as required. This card can be punched (for automatic data collection) or embossed. It ensures positive identification for access to restricted areas. Laminating time is only a few seconds. The machine is compact, easily transported and has a maximum laminating width of 115 mm (4½ in).

Morane thin-film lamination also gives permanent protection to maps, exterior notices, planning charts, etc. Morane systems are supplied to British Ministry of Defence contracts and to many countries throughout the world.

Morane Plastic Co Ltd
Gresham Road, Staines, Middlesex, England
Telephone: Staines 51985
Cables: Morane Staines
Telex: 23917

Mechanical power transmission equipment

Renold Limited is the largest single company in the world devoted solely to the supply of mechanical power transmission equipment. Their range of products comprises power transmission and conveying chains and chain wheels; worm, spur, helical and bevel gearboxes and individual gears; hydrostatic and mechanically operated variable-speed systems; couplings, clutches, brakes and power transmission ancillaries. The company is a supplier to the British Ministry of Defence and can offer a complete range of power transmission products to meet the requirements of all forms of military equipment through a world-wide sales organisation of more than 300 depots in over 100 countries. All enquiries should be made to the address given

Renold Ltd
Renold House, Wythenshawe Manchester, M22 5WL, England
Telephone: 061-437 5221
Cables: Renold Manchester
Telex: 669052

Electric cables, preformed electric wiring assemblies, rigid and flexible printed circuits

Cables are manufactured to British Standard Specifications and are suitable for the temperature ranges from −75°C to 260°C.

Preformed wiring assemblies are designed and manufactured for aircraft jet engines, fighting vehicles and various specialised equipments.

Heat is a major consideration in design for wiring assemblies on jet engines. Wires are often encased in a moulding which is treated to withstand high temperatures. PTFE glassfibres are widely used as cable insulators, but choice of insulating and protective materials is dictated by operating conditions.

Wiring assemblies are purpose-built and designed as far as possible as a single unit to facilitate speed in installation.

Rist's Wires & Cables Ltd
Lower Milehouse Lane, Newcastle Staffs, England
Telephone: Newcastle (Staffs) 561221
Cables: Rist's Newcastle Staffs
Telex: 36301